GUJARAT TECHNOLOGICAL UNIVERSITY
(Established by Government of Gujarat under Gujarat Act No.:20 of 2007)
ગુજરાત ટેકનોલોજીકલ યુનિવર્સિટી
(ગુજરાત સરકારના ગુજરાત અધિનિયમ ક્રમાંક : ૨૦/૨૦૦૭ દ્વારા સ્થાપિત)
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Gujarat Technological University

Student Induction Program (SIP) Guidelines for UG Engineering

w.e.f. Academic Year 2024-25

Student Induction Program (SIP) Guidelines for UG Engineering

Induction training for 3 weeks is mandatory for first year UG Engineering students. The 3-weeks Student Induction Program will help newly admitted undergraduate students for the new stage in their life by facilitating a smooth transition from their home and school environment into the college and university environment through various discussions and activities before formal classes begin. In line with the thoughts expressed in the NEP 2020, the SIP consists of 9 modules – one on Universal Human Values, one on health, five on Indian Knowledge System (modules 4, 5, 7, 8 and 9) and two on skills (modules 3 and 6). The details of modules are mentioned below -

MODULE	Hours
SIP Module 1: Universal Human Values I (UHV I)	**10**
The purpose is to help develop a holistic perspective about life. A universal self-reflective methodology of teaching is adopted. It opens the space for the student to explore his/her role (value) in all aspects of living – as an individual, as a member of a family, as a part of the society and as a unit in nature. Through this process of self-exploration, students are able to discover the values intrinsic in them.	
SIP Module 2: Physical Health and Related Activities	**24**
This module is intended to help understand the basic principles to remain healthy and fit and practice them through a healthy routine which includes exercise, games, sports etc.	
SIP Module 3: Familiarization of Department/ Branch and Innovation	**2**
This module is for introducing and relating the student to the institution/department/branch; how it plays a role in the development of the society, the state, region, nation and the world at large and how students can participate in it.	
SIP Module 4: Visit to a Local Area	**6**
To relate to the social environment of the educational institution as well as the area in which it is situated through interaction with the people, place, history, and politics.	
SIP Module 5: Lectures by Eminent People	**2**
Listening to the life and times of eminent people from various fields like academics, industry etc. about careers, art, self-management and so on enriches the student's perspective and provides a holistic learning experience.	
SIP Module 6: Proficiency Modules	**4**
This module is to help fill the gaps in basic competency required for further inputs to be absorbed. It includes effort to make students proficient in interpersonal communication and expression as well as awareness about linguistics and thereafter NLP.	

SIP Module 7: Literature / Literary Activities including Indian Knowledge System-I (IKS-I)	**16**
Through the exposure of local, national and international literature, this module is aimed at helping the student explore by practicing traditional as well as contemporary values and thought.	
SIP Module 8: Creative Practices	**24**
This module is to help develop the clarity of humanistic culture and its creative, joyful expression through practice of art forms like dance, drama, music, painting, pottery, sculpture etc. Local, national and international case studies, particularly Indian Knowledge Systems, Languages, Culture and Values.	
SIP Module 9: Other Co-curricular Activities	**2**
This is a category under which things that are not placed in any of the above may be placed. Some clubs and hobby groups may be made for each of the above categories, so that students may pursue them even after SIP.	
TOTAL	**90**

SIP Calendar for Bachelor of Engineering

Week	Week 1					Week 2					Week 3				
Session	Mon	Tues	Wed	Thu	Fri	Mon	Tues	Wed	Thu	Fri	Mon	Tues	Wed	Thu	Fri
S- 1	M-3	M-5	M-1	M-1	M-1	M-1	M-1	M-7	M-7	M-7	M-7	M-7	M-7	M-9	M-4
S- 2	M-8	M-8	M-8	M-8	M-8	M-8	M-8	M-8	M-8	M-8	M-8	M-8	M-7	M-7	M-4
S- 3	M-2	M-2	M-2	M-2	M-2	M-2	M-2	M-2	M-2	M-2	M-2	M-2	M-6	M-6	M-4

Note:

- **S-1, S-2 and S-3 are Session 1, 2 and 3 per day.**
- **One session is of two hours.**
- **Mon –Monday, Tues-Tuesday and so on…**
- **M-1, M-2, M-3… are Module 1, 2, 3… and so on…**

Module 1 - Universal Human Value I (UHV I) (10 Hours)

The course is meticulously crafted to nurture students' holistic perspective on life. Our teaching approach is inherently self-reflective, fostering dialogue between students and faculty. It provides a platform for students to delve into their roles and values across various life domains: as individuals, family members, societal contributors, and integral parts of nature. By championing universal human values, the course fosters self-exploration, enhancing comprehension and coherence regarding the universality of human existence. Through this introspective journey, students unearth their intrinsic values, fostering joy in learning, resilience against peer pressure, and the courage to make informed decisions.

This foundational module, integral to the Student Induction Program (SIP), aims to broaden students' understanding of life's complexities, enriching their holistic perspective. Ultimately, these understanding shapes their values, behavior, and quality of life. The curriculum traverse individual, societal, and ecological dimensions, shedding light on diverse interpersonal relationships, human aspirations, and the symbiotic relationship with nature. Emphasizing the paramount importance of health, it underscores the thread that weaves through all endeavors.

The detailed objectives of the Universal Human Values (UHV) module (UHV-I) are as follows:

- Cultivate a holistic life perspective.
- Sensitize students to life's breadth – from individual to societal and ecological realms.
- Foster self-reflection, confidence, and commitment to informed action.

Methodology:

- Embraces a self-reflective teaching approach, facilitating understanding through introspection and dialogue.
- Encourages students to explore their roles and values across life's spectrum.

Session No.	Topic Title	Aspirations and Issues	Basic Realities (underlying harmony)
1	Welcome and Introductions	Getting to know each other	Self-exploration
2	Aspirations and Concerns	Individual academic, career… Expectations of family…	Fixing one’s goals Basic human aspirations Need for a holistic perspective Role of UHV
3 & 4	Self-	Self-confidence, peer	Personality development, self-

Session No.	Topic Title	Aspirations and Issues	Basic Realities (underlying harmony)
	Management	pressure…	improvement… Harmony in the human being
5	Health	Health issues, healthy diet…	Hostel life Harmony of the Self and Body Mental and physical health
6	Relationships	Home sickness, gratitude…	Ragging and interaction Competition and cooperation Peer pressure Harmony in relationship Feelings of trust…
7	Society	Participation in society	Harmony in the society
8	Natural Environment	Participation in nature	Harmony in nature/existence
9	Sum Up	Review role of education Need for a holistic…	Information about UHV-II course, mentor and buddy
10	Self-evaluation	Sharing and feedback	

For comprehensive guidance on content, methodology, and implementation, please consult:

- UHV-I Mentor's Manual for Student Induction Program, Version 2.1 August 2020 https://fdp-si.aicte-india.org/download/G008_Facilitator(Mentor)Manual_Version2.1.pdf
- Presentations for UHV-I (SIP Teaching Material) https://fdp-si.aicte-india.org/SIPTeachMaterialM1.php
- Post UHV-I Feedback and Survey (to be filled by all student participants after they attend UHV-I and submitted to NCC-IP, AICTE /GTU as part of college report) https://fdp-si.aicte-india.org/download/Model Self-Evaluation &Feedback for UHV I Module.pdf

Module 2 - Physical Health and Related Activities (24 Hours)

Course Overview:

This course is designed to provide students with a foundational understanding of the key principles necessary for maintaining health and fitness. Students will apply these principles by establishing a healthy routine that incorporates physical & mental exercise, games, and other activities.

Course Objectives:

- Gaining knowledge of fundamental health and fitness principles
- Applying these principles through activities such as exercise, activities and games
- Engaging with health center personnel, sports coaches, faculties, and students

Relationship Building:

This module provides an exceptional opportunity for students and instructors to form meaningful relationships. By interacting as friends and mentors during and around activities, there is a natural exchange of ideas, making it easier to connect on personal and academic levels.

Lifestyle Practices:

Students will learn to integrate healthy lifestyle choices involving diet, daily routines, and physical activities into their lives. This includes practical tasks such as gardening and farming, which connect students with the broader community and deepen their understanding of real-world challenges and efforts.

Activities Included:

- Team-based and non-competitive games that foster social values and integrity.
- Physical exercises that focus on breathe control and body mechanics.
- Productive physical work, such as creating and maintaining kitchen gardens or plantations, which also provides insights into agricultural challenges.
- By engaging in these activities, students internalize a comprehensive approach to health, transforming these practices into lifelong habits. This course not only improves personal health but also prepares students to contribute positively in various community settings, instilling values of integrity, national pride, and cooperation.

Teaching Methods:

- Health Counselling
- Khel (traditional games)
- Aerobics
- General sports activities
- Yoga

Suggested Modules (2 Hours /Module)

Sr. No.	Module Name	Key Topics Covered	Activities Included
1	Introduction to Health and Fitness Principles	Overview of basic health principles; Setting personal health goals	Discussion and goal-setting exercises
2	Cardio Fitness and Aerobic Exercises	Understanding cardiovascular health; Introduction to aerobic exercises	Guided aerobic exercise session (running, cycling, swimming, etc)
3	Team-Based Sports and Games	Introduction to team-based sports; Teamwork and strategy	Friendly matches in various sports
4	Khel and Traditional Games	Traditional Indian games; Historical significance	Sessions of traditional games
5	Yoga and Breath Control	Basics of yoga and its benefits; Pranayama	Guided yoga and meditation session
6	Diet and Nutrition	Balanced diets and nutritional needs; Role of diet in fitness	Group meal planning activity
7-8	Mental Health and Stress Management	Physical health and mental well-being; Stress management techniques	Mindfulness and relaxation session
9	Role of Sports in Community Building	Social aspects of sports; Inclusivity and teamwork	Team-building games and activities
10	Health Counselling and Goal Setting	One-on-one health counseling; Personal goal setting	Workshop on maintaining healthy habits
11-12	Battery Test	Refer Appendix-A for Detailed Guidelines	

For comprehensive guidance on content, methodology, and implementation, please consult:

- Presentations for Holistic Human Health (SIP Teaching Material) https://fdp-si.aicte-india.org/SIPTeachMaterialM2.php

Appendix-A

A battery test for physical activities typically refers to a series of fitness assessments designed to evaluate different aspects of physical fitness. These tests are used to measure various components like strength, endurance, flexibility, and cardiovascular fitness. Here's an overview of how these tests work and what they typically measure:

Purpose:

The main goal is to comprehensively evaluate an individual's fitness level across different physical capabilities.

The test results help in identifying strengths, weaknesses, and overall fitness levels, and provide guidance for training programs.

Components:

Cardiovascular Endurance:

Assessed through activities like running (e.g., the Cooper test, beep test), cycling, or swimming to measure the efficiency of the heart and lungs.

Muscular Strength:

Measured by tests like the bench press or leg press to assess the maximum force a muscle can exert.

Muscular Endurance: Evaluated through exercises like push-ups, sit-ups, or plank tests to see how long muscles can sustain repeated contractions.

Flexibility:

Often measured with tests like the sit-and-reach test, which gauges the flexibility of the lower back and hamstrings.

Speed and Agility:

Assessed through short sprints or agility drills to measure how quickly an individual can change directions and move.

Body Composition:

Body fat percentage, muscle mass, and BMI are sometimes included in the assessment.

Procedure:

Tests are usually conducted in a structured environment, often by fitness professionals or coaches.

Individuals are guided through a series of exercises with standardized instructions to ensure consistent measurement.

Rest periods between tests ensure accurate results by preventing fatigue from influencing performance on subsequent tests.

Results Interpretation:

Scores or results from each test are typically compared against normative data to assess the individual's fitness level.

Results help in creating personalized fitness programs by targeting areas that need improvement.

Repeated testing at intervals can track progress and evaluate the effectiveness of a training regimen.

Module 3 - Familiarization of Department/ Branch and Innovation (2 Hours)

This module is for introducing and relating the student to the institution/department/branch; how it plays a role in the development of the society, the state, region, nation and the world at large and how students can participate in it.

Sr. No.	Content	Duration
1	Introduction to department, institute and facilities available within and nearby campus (e.g. Faculties, Labs, Major equipment's, clubs, student chapters and nearby research institute and industries).	40 min
2	Role of concern branch of Engineering for the holistic development of the society, nation and world (contribution of branch in Industry sector e.g. Role IC Engineering in automation/agriculture/Process Industry etc. Introduction of prominent alumni from the department and their success journey).	20 min
3	Branch pertaining innovation for sustainable development of society (e.g. E Vehicles for Electrical Engineering, semiconductors for EC Engineering, Nonrenewable for Mechanical Engineering etc.)	30 min
4	Familiarizations with career opportunities (various placement opportunities in government/private sector, scope of entrepreneurship and higher studies).	30 min

Module 4 - Visit to a Local Area (6 Hours)

To relate to the social environment of the educational institution as well as the area in which it is situated through interaction with the people, place, history, politics, provide a brief overview of the day's activities and objectives and assign roles to ensure smooth coordination throughout the day. Below mentioned suggested activities can be followed by the department/ institute located at Ahmedabad city, other institutes can select such places based on their region.

Suggested activities 1: Visit to Gandhi Ashram

- Explore the Gandhi Ashram, also known as Sabarmati Ashram.
- Engage in a guided tour to understand Mahatma Gandhi's philosophy and his contributions to society.
- Reflect on the principles of non-violence, truth, and simplicity.

Suggested activities 2: Heritage Place Visit

- Visit a heritage site such as Adalaj Stepwell or LD Museum.
- Learn about the historical significance and architectural marvels of the site.
- Encourage students to observe and appreciate the cultural heritage of the region.

Suggested activities 3: Visit to Handloom Machineries and Pottery Making

- Experience the traditional craftsmanship of handloom weaving and pottery making.
- Interact with artisans to understand their skills and techniques.
- Participate in a hands-on workshop to create small handicrafts.

Suggested activities 4: Village Visit

- Visit a nearby village to understand rural life and community dynamics.
- Observe various aspects such as agriculture, lifestyle, housing, and social relations.
- Interact with villagers to learn about their daily routines and challenges.

Suggested activities 5: Interaction with Renowned Personalities

- Meet with local personalities who have made significant contributions to society.
- Listen to their experiences and insights on community development and social issues.
- Engage in a Q&A suggested activities to gain valuable knowledge and inspiration.

Concluding remarks:

- Gather for a debriefing suggested activities to reflect on the day's experiences.
- Encourage students to share their thoughts, insights, and newfound perspectives.
- Discuss potential ways to contribute to society and address local challenges.
- Conclude the visit with a group photo and expressions of gratitude.
- Remind students to carry forward the lessons learned and apply them in their lives.
- Provide guidance on further learning opportunities or community engagement initiatives.

By following this schedule, students can gain a holistic understanding of Ahmedabad's cultural heritage, community dynamics, and societal challenges while also fostering empathy, responsibility, and innovative thinking.

Module 5 - Lectures By Eminent People (2 Hours)

Guest lectures by eminent persons from various fields such as academics, industry, sports, business, and technology offer students an exceptional opportunity to broaden their perspectives and gain insight into the practical aspects of life and work. These lectures are not only a source of inspiration but also serve as a valuable platform for students to connect with experienced professionals who have achieved success in their respective areas.

The impact of guest lectures extends far beyond merely listening to accomplished individuals share their stories. Such interactions can profoundly shape students' understanding of the world and equip them with knowledge and skills that are not always covered in traditional classroom settings. Here are several key benefits that students can gain from engaging with guest speakers from different fields:

1. **Inspiration and Motivation**: Eminent persons often share their journey, including the challenges they faced and the strategies they used to overcome them. This can inspire students to pursue their goals with determination and resilience. Hearing about the achievements of these figures can motivate students to strive for excellence in their own endeavours.
2. **Career Guidance**: By learning about the diverse career paths and experiences of guest speakers, students can gain insight into various industries and professions. This exposure can help them make informed decisions about their own career choices and explore opportunities they may not have considered otherwise.
3. **Real-World Insights**: Guest speakers bring a wealth of practical knowledge and experience to the table. Through their lectures, students can gain a deeper understanding of the current trends, challenges, and opportunities in different fields. This real-world perspective can complement theoretical learning and prepare students for the professional world.
4. **Networking Opportunities**: Engaging with guest speakers provides students with the chance to build valuable connections with professionals in their fields of interest. Networking can open doors to internships, mentorships, and potential job opportunities, giving students a head start in their careers.
5. **Exposure to Diverse Perspectives**: Inviting speakers from various backgrounds and fields allows students to encounter a wide range of viewpoints and experiences. This exposure can broaden their horizons and encourage them to think critically and creatively about different topics.
6. **Development of Communication Skills**: Guest lectures offer students the chance to interact with professionals, ask questions, and engage in discussions. This interaction helps students improve their communication skills and gain confidence in expressing their thoughts and ideas.
7. **Learning from Experienced Mentors**: Guest speakers often share valuable advice and insights from their own experiences. Students can benefit from these lessons and apply them to their personal and professional development.

To maximize the benefits of guest lectures, it is important to invite a diverse set of speakers from different fields. This diversity ensures that students are exposed to a wide range of topics and perspectives, enriching their overall learning experience. Additionally, the interactive nature of guest lectures allows students to engage with the speakers and ask questions, fostering a dynamic learning environment.

In conclusion, guest lectures by eminent persons from various fields play a crucial role in enhancing students' education and personal growth. By providing inspiration, guidance, and real-world insights, these lectures contribute to a well-rounded learning experience that prepares students for success in their future endeavours.

Note: Guest lectures are a valuable way to enrich students' perspectives and broaden their understanding of different fields. However, it can be challenging for institutions in rural areas to host eminent speakers in person. Additionally, large institutions may face difficulties in organizing lectures for all classes with a single speaker. To address these challenges, Gujarat Technological University will facilitate a unified online lecture series featuring distinguished speakers, accessible to all affiliated institutes. This online format ensures that students across various locations and institutions can benefit from the insights and experiences shared by the guest speakers. However, institutes are free to host eminent speakers in offline mode, if it can be managed by them.

For further information please refer: SIP Handbook from AICTE.

Module 6- Proficiency Module (4 Hours)

Objective:
This module aims to fill the gaps in basic competencies required for further learning. It focuses on developing proficiency in English Language, Gujarati/Hindi Languages, Communication Skills and relevant Computer Skills. The module is designed to cater to students of diverse backgrounds and help them adapt to the medium of instruction (English) and enhance their overall communication abilities.

Expected Outcome:
Equip the students to develop competencies required in further advancement of their UG studies.

Methodology:

1. Reading of printed materials like Newspaper, short stories, books, articles, drama, periodicals, etc.
2. Use of Web tools
3. Use a variety of methods to engage learning
4. Use of Audio/ Visual Tools
5. Build in work groups
6. Expert Sessions

Session 1: English Proficiency (1 hour)

- Introduction to the importance of English proficiency in academic and professional settings.
- Interactive activities to encourage speaking in English without fear of making mistakes.
- Group discussions on various topics to improve fluency and confidence.
- Watching short videos or movies in English followed by discussions.
- Tips and guidelines for self-improvement in English (e.g., reading newspapers, writing, conversing with friends in English).

or

Session 1: Gujarati / Hindi Proficiency (1 hour)

- Basic introduction to the Gujarati/ Hindi language for students not familiar with it.
- Common phrases and expressions used in Gujarati/Hindi.
- Practice sessions for basic Gujarati/ Hindi conversations.
- Introduction to Indian epics, dramas, and literature in Gujarati/Hindi.
- Watching short videos or movies in Gujarati/ Hindi followed by discussions.
- Tips and guidelines for self-improvement in Gujarati/ Hindi (e.g., reading newspapers, writing, conversing with friends in Gujarati/ Hindi).

Session 2: Communication Skills (1 hour)

- Importance of effective communication in personal and professional life.
- Active listening exercises.

- Role-playing scenarios to practice different communication skills (e.g., assertiveness, empathy).
- Tips for improving non-verbal communication (e.g., body language, eye contact).

Session 3: Computer Skills (1 hours)

- Basic introduction to computers for preparation of presentation, word documents etc.
- Hands-on practice with common software applications (e.g., word documents, spreadsheets, PowerPoint presentation).
- Accessing the internet for learning pronunciation, synonyms and antonyms etc.
- Introduction to coding and digital literacy.
- Introduction to plagiarism software
- Use of NLP tools

Session 4: Expert session (1 hour)

- Introductory session on IELTS and TOEFL
- Effective Speaking Skills, Voice Quality and Purposeful writing
- Body Language and Listening skills
- Hands-on practice with NLP tools

Note:

- The sessions should be interactive and engaging, encouraging active participation from all students.
- Provide a supportive environment where students feel comfortable making mistakes and learning from them.
- Offer additional resources and support for students who need extra help.
- Encourage students to continue practicing and improving their skills beyond the induction module.

Resources:

1. English (or other language) Newspaper, articles, story books, etc.
2. Audio and Video clips
3. Online Vocabulary

Module 7 - Indian Knowledge System (16 Hours)

(भारतीय ज्ञान प्रणाली)

INDIAN civilization has always attached great value to knowledge. In Bhagvad Gita, Shree Krishna says – "न हि ज्ञानेन सदृशं पवित्रमिह विद्यते।" - Indeed, there is nothing purifying here comparable to Knowledge.

The Indian Knowledge System talks about two types of knowledge (विध्या), one अपराविध्या (worldly knowledge) and पराविध्या/ब्रह्मविध्या (knowledge which liberate). However, it is common perception that the body of knowledge represented in our Indian Scriptures are only related to some ritual practices. On the contrary, there is an amazingly large body of intellectual texts, the world's largest collection of manuscripts, its attested tradition of texts, thinkers and schools in so many domains of knowledge.

It is an interesting and fascinating aspect of knowledge in India that it prevails in diverse ways and is expressed at varied levels. In many areas such as Medicine, Mathematics, Science and Technology, Psychology, Philosophy, Agriculture, Grammar, Language, Dance, Music and Astrology, to name just a few, there is wide and extensive knowledge both at the level of the classical texts and the folk traditions. Quite commonly, they are referred to as "Shastra" and "Lok Parampara" respectively.

This module is aimed at introducing this great tradition of knowledge to the engineering students. This module will introduce scientific and technological aspects of the great Indian Knowledge System.

The Learning Objectives of this module is as follows:

After completing this module students will be able to discuss about –

1. Various texts and traditions of Indian Knowledge System
2. Scientific aspects of Sanskrit and its Grammar
3. Indian contribution in mathematics, science, technology, philosophy, health and psychology.

This module is planned in 16 hours of teaching – learning activities as below -

Session No.	Topic Title	Hours
1	Introduction to IKS	1
2	The Vedic Corpus	1
3	Indian Philosophical System	1

Session No.	Topic Title	Hours
4	Scientific Foundation in Linguistics (Sanskrit)	1
5	Computational Concept in Panini	1
6	Indian Number System	1
7	Ancient Indian units of measurements	1
8	Indian Mathematics	1
9	Indian Mathematics	1
10	Metals and Metalworking	1
11	Metals and Metalworking	1
12	Various other applications	1
13	Various other applications	1
14	Town planning and architecture	1
15	Health, Wellness and Psychology	1
16	Health, Wellness and Psychology	1

Reference study materials:

1. Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan, Vinayak Rajat Bhat, and Nagendra Pavana R.N.; Publisher: Prentice Hall India
2. Set of five books published by School of IKS (धरोहर), GTU.

Module 8 - Creative Practices (24 Hours)

Course Overview:

This module is designed to enhance an appreciation for humanistic culture through the lens of engineering, encouraging students to explore and integrate creative expressions with technical disciplines. Students can have the opportunity to select a skill from a variety of domains that complement their engineering studies. Additionally, literary activities such as reading, writing, and debating are included to foster critical thinking and articulate expression, essential skills for any engineer.

Course Objectives:

The program's goals are to establish a dynamic and collaborative environment that enhances social interactions and skill development, while also fostering an appreciation for creative arts as a complementary aspect to engineering education. Participants will engage in various activities including group projects and competitions. These will culminate in a showcase where students can display the innovative skills they have acquired. Engineering societies and clubs may assist in organizing these activities, providing a bridge between technical and creative disciplines.

Furthermore, professionals from fields that intersect with both the arts and engineering, such as industrial design, sound engineering, and architectural design, may be invited to lead workshops. These sessions will provide students with the opportunity to develop creative and practical solutions to challenges that are relevant both in artistic and engineering contexts.

Throughout the program, students will commit daily time to explore and integrate artistic disciplines into their engineering projects. While a central theme—such as sustainability, innovation, the history of engineering, or technology's impact on society—may guide these activities, participation in this thematic exploration is not mandatory. This approach is designed to deepen students' engagement, encouraging them to apply artistic expressions such as design, modelling, or conceptual installations to enhance their understanding of engineering principles. This thematic involvement is intended not only to enrich students' technical and creative skills but also to heighten their social and ethical awareness as future engineers.

Activities Included:

Recognize the Role of Creativity in Engineering: Students will identify and understand how creative thinking contributes to technological innovation and problem-solving in engineering contexts.

Develop Creative Problem-Solving Skills: Students will learn to apply creative problem-solving techniques to tackle complex engineering problems, integrating unconventional solutions and innovative approaches.

Enhance Observational Skills: Students will improve their ability to observe and analyze everyday objects and systems, fostering the ability to see potential improvements and innovations.

Practice Ideation Techniques: Students will practice various ideation methods such as brainstorming, mind mapping, and SCAMPER to generate new ideas and approaches for engineering projects.

Experiment with Design Thinking: Students will engage in design thinking processes to empathize with users, define problems, ideate solutions, prototype, and test, emphasizing user-centered design in engineering.

Cultivate Interdisciplinary Thinking: Students will explore how concepts from other disciplines can be integrated into engineering solutions, encouraging a broader perspective and versatile problem-solving skills.

Apply Creative Tools and Technologies: Students will learn to use modern tools and technologies that facilitate creative design and engineering, such as CAD software, 3D printing, and digital simulation tools.

Develop Reflective Practices: Students will engage in reflective practices to critique and evaluate their creative processes and outcomes, leading to continuous improvement in their creative endeavours.

Encourage Collaboration and Teamwork: Students will participate in group projects that require creative collaboration, learning how diverse perspectives can contribute to innovative solutions.

Promote the Presentation of Creative Work: Students will develop skills in effectively communicating their innovative ideas and creative projects to diverse audiences, including peers, instructors, and industry professionals.

Professional Development: Hosting exhibitions and performances where industry professionals are invited can provide networking opportunities and expose students to potential career paths that combine engineering and the arts.

Workshops and Masterclasses: Organize workshops led by professionals in different fields such as painting, music, dance, and drama. These can provide hands-on experiences and deepen students' skills.

Suggested Modules (2 Hours /Module)

Sr. No.	Module Name	Key Topics Covered	Activities Included
1	Introduction to Creative Arts in Engineering	Basics of creativity in engineering with arts focus	Discussion on the intersection of arts and engineering
2	Creative Writing for Engineers	Basics of creative writing; Writing for technical audiences	Short writing exercises; peer feedback
3	Visual Arts and Design Thinking	Design thinking basics; Drawing and visual design	Guided drawing and visual design exercises
4	Observation and Creative Inspiration	Observational skills; Finding inspiration in daily life	Sketching and journaling activities
5	Basics of Collaboration through Theatre	Importance of collaboration; Acting basics	Improv games and collaborative acting exercises
6	Storytelling through Technology	Digital storytelling; Simple digital media tools	Creating digital stories using basic media tools
7	Art and Engineering Concepts	Exploring how art intersects with engineering	Group discussions and practical activities exploring artistic concepts
8	Reflective Practices through Literature	Importance of self-reflection; Literature analysis	Short readings and reflective journaling
9	Team Projects in Creative Arts and Engineering	Planning and executing interdisciplinary projects	Group projects combining art and engineering
10	Basic Presentation Skills	Introduction to presenting creative work	Group presentations and feedback sessions
11	Career Paths in Creative Arts and Engineering	Overview of careers blending arts and engineering	Guest talks from professionals in creative fields
12	Beginner Workshops in Creative Skills	Guided skill-building in arts and engineering	Hands-on workshops with creative professionals

For comprehensive guidance on content, methodology, and implementation, please consult:
Presentations for creative practices: https://fdp-si.aicte-india.org/SIPTeachMaterialM8.php

Module 9 - Extra Curricular Activities (2 Hours)

This is a category under which things that are not placed in any of the above may be placed. This has suggestions for sessions or activities that can be conducted like some clubs and hobby groups may be made for each of the above categories, so that students may pursue them even after SIP.

Anti-Ragging Briefing: With the advent of college years for students, fear of ragging creeps inside them. With a picture of ragging borrowed from the cinema in their minds, they enter the premises, and hence it becomes essential to introduce them to the rules of the institution against ragging. Many students are away from their homes for the first time, and it is the responsibility of the institute to make them feel welcomed and safe within the boundaries of the institute Both formal and informal sessions can be organized informing the entrants about the anti-ragging policies of the institution, along with answering some principal questions like, "What comes under ragging?", "Whom to approach if you witness ragging?", etc.

Wellness Sessions: In this ever-growing competitive world, statistics of mental issues like depression and anxiety are overwhelming, and yet people choose to overlook these issues. "Mental awareness/wellness sessions" provide an answer to this ignorance. The institute can have tie-ups with mental wellness organizations that, in-return, can send in their professionals to deliver lectures on mental health and its importance. Informal sessions by specialists can be organized involving fun yet, affective activities (self-control activities, music therapy activities, discussion activities, or relaxation activities like games to release stress and have a bonding with the peers) to maintain a healthy state of mind. Because of the stigma around mental health, the information of the student approaching for help shall be confidential, and a team of students themselves can be set up to hear out issues of their juniors and help them out professionally.

Informal Interactions: A fresher, oblivious to the college culture and environment, requires informal interactions with seniors to clear their queries regarding the workload of the branches, different clubs, excelling in exams, opportunities provided by the institute to pursue their interests, and maybe even professors. Seniors, accompanied by faculty members, should visit the hostels of freshers post dinner to make them feel welcomed and comfortable. Seniors accordingly may choose to sit in the corridors or grounds to share their experiences of their freshmen year and to answer the questions raised by the freshers. Faculties shall be roaming through the hostels to ensure no cases ragging take place. Occasionally refreshments could be taken by the faculties to bond and interact with the freshers. The faculty members shall make sure that all the seniors are out of the fresher's hostels at the end of these sessions.

Club/Council/Committee Briefings: Clubs/Council/Committee are a vital part of a college's ecosystem and it is thus imperative that students are well briefed regarding them. The details of the briefing will vary from college to college, but the brief outline has been described here, along with the reasons that

make such a briefing essential. It would be advisable to have the Secretaries/Presidents and other position holders draft a welcome address for the new entrants. This should serve as an advertisement for the club's activities, scope and culture. A member of the Debate Club, for example, should go through an analysis of why learning how to debate is a useful/interesting skill and how the club members would help the new entrant learn and develop these skills. Similarly, a member of the Design Club could have the club members showcase their skills through a quick extempore portrait creation. This would be quite engaging and entertaining for the spectators. If there are any committees which are not student-run, the people in charge could take it upon themselves to organize this presentation for the students. The main objective would be to ultimately ensure that every student goes into the academic year with a very strong basic idea of what to expect from a club and whom he or she could contact in order to have a better idea of what to do. Intra Fresher Competitions: Care must be taken to have as relaxed a schedule as possible so that any student can freely participate in as many events as possible without having to pick and choose between different interests.

One suggestion would be to introduce a points system and have a competition among different branches on the basis of that. The ones who end up on the podium in a particular event will contribute a certain number of points to their branch and will get some personal rewards as well. Broadly speaking, there could be three categories of competitions held: Cultural, Technical and Sports. For example under Cultural, activities like Debate, Dance, Singing, etc. can be conducted.

A. General Regulations:

1. Every student has to maintain a daily diary. Format of the diary is given.
2. After completion of the Induction program student has to prepare a report based on activities performed during the Induction program. Diary will be attached as Appendix in Report.
3. 75% Attendance is required during the Induction Program.
4. This program will be a noncredit subject but it will reflect in the 1st Semester Marksheet as PASS or FAIL.
5. The Institute should appoint a mentor for a group of 20 to 30 students. Mentors can take help from senior students.
6. If a student gets an admission transfer in another college during the Induction Program, the diary will be continued from previous college to new college.
7. If a student gets admission in the middle of the Induction Program or student gets admission after the Induction Program, it is the responsibility of the institute to fulfill the criteria of the Induction Program.
8. If a student fails in the Induction program, the student has to clear the same during subsequent Semester.

B. Evaluation Pattern:

1. The Induction Program is Mandatory course for each branch of UG Engineering.
2. It is mandatory for each student to clear the Induction Program with PASS grade.
3. Grades for the Induction Program are either PASS or FAIL and have no credits. Evaluation for the Induction Program is based on the Induction Program Report prepared by a student from the student diary and the student will be declared PASS or FAIL.
4. Students have to submit the Induction Program Report at the end of first semester duly approved by Mentor and HOD.
5. Evaluation of the Induction Program will be done along with the first Semester Term-Work Submission.
6. The evaluation is carried out by the Internal Examiner from the institute itself. The entry on the GTU portal will be PASS or FAIL, not marks.
7. The students who will FAIL have to reappear again after every 6 months as a remedial exam.

C. Guidelines for Program Report:

1. Report should have a minimum of 20 pages.
2. Report must have One Photograph per Activity.
3. Report consists of Certificate, Index and Diary as Appendix.
4. Report should be duly signed by Mentor and HOD.
5. Index will have following sequence:

Sr. No.	Name of Modules
Module 1	Universal Human Values I (UHV I)
Module 2	Physical Health and Related Activities
Module 3	Familiarization of Department/ Branch and Innovation
Module 4	Visit to a Local Area
Module 5	Lectures by Eminent People
Module 6	Proficiency Modules
Module 7	Literature / Literary Activities including Indian Knowledge System-I (IKS-I)
Module 8	Creative Practices
Module 9	Other Co-curricular Activities

D. Format of Diary

Format of Diary is attached as Annexure- 01.

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: ALL

Subject Code : BE01R00021

Subject Name : Physics

w. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	BSC

Prerequisite:	Basic understanding of Calculus, Physics and Mathematics course on Differentiate equations
Rationale:	The basic science - physics program is to prepare students for careers in engineering where physics principles can be applied to the advancement of technology. This education at the intersection of engineering and physics will enable students to seek employment in engineering upon graduation while, at the same time, provide a firm foundation for the pursuit of graduate studies in engineering.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	The student will apply theoretical and mathematical concepts to solve problems related to properties of matter.	Apply
02	The student will apply basic principles, properties, and applications associated with Waves, Motion, and Acoustics to practical situations	Apply
03	The student will apply basic principles, properties, and various methods of production techniques in Optics to solve real-world problems.	Apply
04	The student will apply fundamental principles of Quantum Physics to analyze and interpret quantum phenomena.	Apply
05	The student will apply the principles of Lasers to understand their properties and applications in science, engineering, and medicine..	Apply
06	The student will apply knowledge of new engineering materials, including semiconductors, superconductors, and nanomaterials, to practical engineering problems.	Apply

**Revised Bloom's Taxonomy (RBT)*

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: ALL

Subject Code : BE01R00021

Subject Name : Physics

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL(I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

**** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**PROPERTIES OF MATTER** • Stress – Strain – Hooke's law – • Elastic Behaviour of Material – • Young's modulus by cantilever depression – • Non-uniform bending – • Uniform bending- • Application -I-shaped girders. • Torsional Pendulum – Couple per unit twist of a wire, Time period, • Application- Determination of Rigidity Modulus.	**6**	**13**
2.	**WAVES, MOTION AND ACOUSTICS** • Simple Harmonic motion, Free, forced, Resonance, • Damped and undamped vibration, • Damped harmonic motion, • Force vibration and amplitude resonance, • Velocity resonance and energy intake, • Wave motion, transverse and longitudinal vibration, • Sound absorption and reverberation, • Sabine's formula and usage (excluding derivation), • Acoustic of building,	**8**	**18**

	• Ultrasonic waves - Properties - Generation – Piezoelectric method – Detection- Kundt's tube • Application of Ultrasonics in industries – NDT.		
3.	**OPTICS** • Huygens' Principle: Fundamental principle for wave propagation. • Superposition of Waves: Basic principle for understanding interference and diffraction. • Explanation of constructive and destructive interference. • Applications in thin film interference, such as soap bubbles and oil films. • Young's double slit experiment. • Newton's rings, • Michelson Interferometer • Anti-reflection coating. • Fresnel and Fraunhofer diffraction– diffraction due to 'n' slits-plane transmission grating. • Rayleigh criterion for limit of resolution - resolving power of grating.	**8**	**18**
4.	**QUANTUM PHYSICS** • Black body Radiation-Planck's law • Energy distribution function, • Wave-particle duality-de Broglie matter waves • Concept of the wave function and its physical significance – Heisenberg's Uncertainty Principle • Schrodinger's wave equation – Time-independent and Time-dependent equations – • Particle in a one-dimensional rigid box – tunneling (Qualitative) – Scanning Tunnelling Microscope.	**8**	**18**
5.	**LASERS** • Properties of Laser, Einstein's theory of matter radiation: A and B coefficients, • Amplification of light by population inversion,	**8**	**18**

	• Different types of lasers, • Gas lasers (He-Ne), • Solid-state lasers (Ruby laser), • Properties of laser beams: Mono-chromaticity, coherence, directionality and brightness, laser speckles, • Applications of lasers in science, engineering, and medicine.		
6.	**NEW ENGINEERING MATERIALS** SEMICONDUCTOR MATERIALS: • Introduction of Group IV elements, • Properties, • Concept of carriers, • Concept of bands and band gap, • P-type, N-type materials • Introduction to P-N Junction Diode and I-V characteristics, • Zener diode and its characteristics SUPERCONDUCTING MATERIALS: • Introduction – Properties • Meissner effect • Type I & Type II superconductors • Applications. NANOMATERIALS: • Introduction • Synthesis of nano materials – Top down and Bottom up approach • Ball milling • PVD method • Applications.	**7**	**15**
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
30	**40**	**30**	**0**	**0**	**0**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Engineering Physics by Dattu R Joshi, McGraw hill Publications
2. Engineering Physics by Shatendra Sharma & Jyotsan Sharma, Pearson Publication
3. Optics by Subramaniam N & Brij Lal, S Chand & Co. Pvt. Ltd., New Delhi
4. Optics by R.Agarwal, S. Chand
5. Fundamentals of Optics by Jenkins A Francis and White E Harvey, McGRaw Hill Inc., New Delhi,
6. Concepts of Modern Physics by Arthur Beisser, McGraw Hill
7. Modern Physics by R Murugeshan, Kiruthiga, Sivaprasath S Chand
8. Quantum Mechanics by V. Devanathan, Narosa, Chennai
9. Quantum Mechanics by Sathyaprakash, Pragati Prakashan, Meerut
10. Engineering Physics by M.N.Avadhanulu, S.Chand & Company
11. Engineering Physics – Bhattacharya, Bhaskaran – Oxford Publications
12. Engineering Physics I & II – G. Senthilkumar, VRB publications
13. Applied Engineering Physics – Rajendran & Marikani (Tata McGraw Hill)
14. Applied Physics for Engineers – K.Venkatramanan, R.Raja, M.Sundarrajan (Scitech)
15. Principles of Electronics by V.K.Mehta, (S.Chand)
16. Basic Electronics by B.L.Theraja, S.Chand
17. Mechanics of Materials, Barry J. Goodno, James M. Gere, Published
18. Fundamentals of Physics, D. Halliday, R. Resnick and J. Walker, John Wiley and Sons, New York.

(b) Open source software and website:

1. https://nptel.ac.in/
2. https://www.vlab.co.in/

Suggested Course Practical List: If any

List of Experiments:

1. Diffraction and interference experiments (from ordinary light or laser pointers); measurement of the speed of light on a tabletop modulation; minimum deviation from a prism.
2. Measurement of the Distance using Ultrasonic Sensors.
3. Study of Object Detection using Ultrasonic Sensors.
4. Melde's Experiment Transverse and Longitudinal Modes
5. To determine the frequency of a given laser source.
6. Frequency of AC Supply-Sonometer method
7. Wavelength of Light -Diffraction Grating using LASER
8. Acoustic grating method set up for measurement of the velocity of ultrasonic waves in liquid
9. Melde's experiment Resonator
10. Study of Damped Simple Harmonic Motion
11. Newton's rings, Determination of using sodium light.
12. Calibration of Spectrometer & determination of unknown wavelength
13. Dispersive curve of a prism
14. Study of Fabry-Perot Etalon
15. Study of Lloyd's Mirror
16. Study of Double Refraction in Calcite Prism
17. Virtual Heat & Thermodynamics Lab
18. Virtual Advanced Mechanics Lab
19. Virtual Laser Optics Lab
20. Virtual Harmonic Motion & Waves Lab
21. Virtual Optics Lab
22. Virtual Modern Physics Lab
23. Virtual Lab on oscillations
24. Virtual Physical Sciences Lab

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Multimedia based conceptual learning of topics related to Physics	Duration = 5h Report preparation = 3h **Total = 8h**	Report /presentation based on the learning outcomes.
2.	Assignment writing (Numericals based assignment is preferable)	6 assignments of 2h each. **Total = 12h**	Based on the assignment submitted.

3.	Self-learningthrough virtual lab experiments(2 Experiments)	Performance = 4 h Report preparation = 2 h **Total = 6 h**	Assessment based on report and viva
4.	Poster/chart preparation on technical topics	**Total = 4 h**	Based on poster/chart preparation
5.	Working model on technical topics and report writing	Idea = 2 h Execution =6 h Report + Presentation = 4 h **Total = 12 h**	Based on inter department/external evaluation
6.	Assembly of Circuit on the bread board	Duration = 3 h Report preparation = 3 h **Total = 6 h**	Based on circuit and clarity of components used
7.	power point preparation on technical topics and presentation	Preparation = 4 h Presentation = 2 h **Total = 6 h**	Based on ppt prepared, presentation and viva
8.	Study of different physics principles involved in technical industrial equipment/ tools/ processes	Survey/ study = 4 h Report preparation = 4 h **Total = 8 h**	Based on report
9.	Study of units, conversion and use	Preparation = 4 h Quiz = 1 h **Total = 5 h**	Based on performance in quiz

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Degree

Branch: All branches

Course / Subject Code : BE01R00031

Course / Subject Name : Chemistry

w. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	BSC

Prerequisite:	Basic knowledge of general chemistry.
Rationale:	Every material is made up of atoms. Material is deeply integrated with engineering, therefore, basic chemistry is essential to understand the nature and properties of material. The selection, characterization, and suitability assessment of natural raw materials essentially requires principles and concepts of basic chemistry. Successful completion of this course content will enable engineers to understand, ascertain and analyze the various new materials and enable to solve engineering problems.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Define chemical properties of atom, molecule, metal, alloys and energy sources.	R
02	Relate atomic and molecular structure with their reactivity	U
03	Solve the engineering problems related to fuel, water and corrosion	A
04	Compare recent Nano-material, ecofriendly materials and energy storage devices	E
05	Analyze properties of materials by various tools.	N

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

**** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Degree

Branch: All branches

Course / Subject Code : BE01R00031

Course / Subject Name : Chemistry

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Basic chemistry:** Wave mechanical concept of structure of atom; de Broglie's concept, Heisenberg's uncertainty principle, Schrodinger's wave equation. Shape and structure of diatomic molecules; types of hybridization (sp, sp^2, sp^3, sp^3d and sp^3d^2). Hard soft acids and bases concept and its applications.	8	18
2.	**Water technology:** Hardness of water, softening of water, boiler problems; caustic embrittlement, sludge, scale, priming and foaming. **Corrosion:** Introduction to corrosion, theories of corrosion, types of corrosion, protective measurements against corrosion; organic and inorganic materials, inhibitors, cathodic protection.	10	22
3.	**Material chemistry:** Properties and applications of fullerenes, fullerols, carbon nanotubes, nanowires and metal nanoparticles. Top down and bottom up approaches for synthesis of nanomaterials. Biodegradable polymers. Bio-based feedstock. **Metals and Alloys:** properties and applications. Heat treatments of steel. Types of alloys, Alloys of copper, aluminum and nickel.	10	22
4.	**Fuel and batteries:** Refining of petroleum, determination of calorific value by bombs calorimeter, Knocking and octane number. Ultimate and proximate analysis of coal. Biofuels; Biodiesel and biomass briquettes. Introduction to rechargeable cells, lithium batteries; construction and working. Photolysis of water. **Fermentation:** Synthesis of ethanol, acetic acid and pharma products by fermentation.	10	22
5.	**Instrumental analysis:** Principle and working of UV-Visible, Infra-Red, and NMR spectroscopy and their applications. Introduction to chromatographic techniques; thin layer chromatography, gas chromatography, liquid chromatography.	7	16
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
16	**16**	**36**	**11**	**21**	**0**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Engineering Chemistry, Willey-India.
2. Engineering Chemistry by Jain and Jain, Dhanpat Rai Publishing Co.
3. Engineering Chemistry by Marry Jane Shultz, Cencage Learning.
4. Engineering Chemistry by N. Krishnamurthy, P. Vallinaygam and D. Madhavan, PHI Learning.
5. Engineering Chemistry by K. Sesha Maheswaramma and Mridula Chugh, Pearson India Education Pvt Ltd.
6. Engineering Chemistry by B K. Sharma, Krishna, Prakashan Media (P) Ltd.
7. A textbook of Engineering Chemistry by Shashi Chawla, Dhanpat Rai Publishing Co. Ltd.
8. Fundamentals of Biotechnology by B D Singh, Kalyani Publisher. New Delhi.
9. Essential of Physical Chemistry by Bahl and Tuli., S Chand & Co. Ltd, New Delhi.
10. Introduction to Nano Science by N N. Lindsay, Oxford University Press.
11. NANO: The Essentials by T Pradeep Tata McGraw-Hill Publishing Company, New Delhi.

(b) Open source software and website:

1. https://nptel.ac.in/
2. https://chem.libretexts.org/Courses/Remixer_University/Download_Center
3. https://ocw.uci.edu/collections/open_chemistry.html#
4. https://ocw.mit.edu/courses/5-111sc-principles-of-chemical-science-fall-2014/

Suggested Course Practical List:

1. To determine the total hardness of the given samples by EDTA titrimetric method.
2. To estimate moisture content in the given coal sample.
3. To determine the amount of alkalinity present in the given samples.
4. To determine the amount of chloride present in the given water sample by Mohr's method.
5. To determine the saponification value of an oil sample.
6. To determine the concentration of unknown solution by spectrophotometer.
7. To determine the percentage of iron in the given steel sample.

8. To determine the amount of copper in a given brass sample.
9. To study the rate of corrosion by weight loss method.
10. To carry out analysis of pyrolusite ore.
11. To determine the R_f value of given sample by TLC method.
12. To synthesis of metal nanoparticles (silver, gold or copper etc.)

(Minimum 8 experiments to be performed)

List of Laboratory/Learning Resources Required:

1. Spectrophotometer.
2. Laboratory oven.
3. Melting point Instrument.
4. Electronic balance
5. TLC plates
6. Various chemicals and glassware

Suggested Project List:

1. Construction of bio-reactor
2. Construction of Li-cell
3. Set-up for photolysis of water
4. Synthesis of bio-degradable polymers
5. Design concept based on circular economy

Any other suitable project suggested by mentor or students.

Suggested Activities for Students:

1. Industrial visit
2. Organizing seminar and workshop
3. Participate in technical events
4. Participate and involve in startup

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Description	No. Of hours	Total Hrs.
1	Students will have to undergo industrial visit related to any one of the content mentioned in syllabus and submit the report for the same.	Visit = 5 hrs Report Preparation = 5 hrs	**10**
2	Students will have to undergo technical video based learning related to subject and have to present it or prepare a report of that learning.	Duration of video = 5 hrs Report Preparation = 5hrs	**10**
3	Students will have to submit assignment work assigned to them. Numerical base assignment is preferable.	5 assignments of 2 hrs each.	**10**
4	Self learning on-line course.	Min. Duration of the course should be 10 hrs	**10**
5	Discussion on research papers based on relevant subject. Summarize research papers and evaluation critical parameters.	5 research papers can be included. Each one has 5 hrs	**25**
6	Students will have to prepare posters, charts or PowerPoint presentations on technical topics related to subject content.	Duration of each activity = 6 hrs Max. two topics can be considered.	**12**
7	Students will have to do Group Discussion on emerging, Trending technical topics based on the subject.	Preparation and discussion on one topic	**5**
8	Flipped Classroom Activity	Preparation and discussion on one topic	**5**
9	Hands-On Experiments and Virtual Labs	Duration of video = 4 hrs Journal Preparation = 4hrs	**8**

10	Identification and remediation of the chemical processes that lead to pollution, climate change.	Research=3 hrs Report preparation=2 hrs	**5**
11	Working/ Non working models on technical topics.	Working= 12 hrs Non working = 8 hrs	**12/8**
12	Online Technical Quizzes/Simulations.	Multiple quizzes summing up to 10 hrs	**10**
Max. Hours to be allotted			**45**

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Degree

Branch: All

Course / Subject Code : BE01R00041

Course / Subject Name : Mathematics – 1

w. e. f. Academic Year:	2024-25
Semester:	Ist semester
Category of the Course:	BSC

Prerequisite:	Basic Algebra, Geometry, Trigonometry and Calculus
Rationale:	The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	To apply differential and integral calculus to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.	A
02	The fallouts of Taylor's and Maclaurin's Theorem that is fundamental to application of analysis to Engineering problems.	A
03	The tool of Sequences and Infinite series for learning advanced Engineering Mathematics.	A
04	To deal with functions of several variables that is essential in most branches of engineering.	A
05	To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
30	30	00	60	120	04	70	30	00	30	00	130

**** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Module 1: Basic Calculus:** Evaluation of improper integrals of Type-I and Type-II, Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions	9	20%
2.	**Module 2: Single-variable Calculus (Differentiation):** Taylor's and Maclaurin's theorem for a function of one variable, Taylor's and Maclaurin's series of a function using statement of the theorems; Extreme values of functions; Indeterminate forms and L' Hospital's rule.	9	20%
3.	**Module 3: Sequences and series:** Sequence of numbers and its convergence, Infinite series; Tests for convergence (Telescoping series, Geometric series test, Integral test, p-test, comparison test, D' Alembert's ratio test, Cauchy's root test), Alternating series test; Power series, Radius and interval of convergence, Conditional and Absolute convergence of a power series	9	20%
4.	**Module 4: Multivariable Calculus (Differentiation):** Limit, Continuity and Differentiation for function of two or more variables, total derivative, gradient, directional derivatives; Tangent plane and Normal line to the surface $f(x, y, z) = c$; Extreme values for function of two variables (Maxima, minima and saddle points); Method of Lagrange multipliers.	9	20%
5.	**Module 5: Multivariable Calculus (Integration):** Multiple Integration: Double integrals (Cartesian, Polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian, Cylindrical, Spherical).	9	20%
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	35	15	0	0	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
4. AICTE's Prescribed Textbook: Mathematics-I (Calculus & Linear Algebra), Khanna Book Publishing Co.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

(b) Open source software and website:

1. MIT Open Courseware (https://ocw.mit.edu/search/?s=department_course_numbers.sort_coursenum)
2. NPTEL Open Courseware (https://nptel.ac.in/)

- **List of suggested activities for Problem Based Learning:**

Activity	No. of Hours	Total Hours Claimed	Evaluation Criteria
Assignments on topics like Improper integrals, beta -gamma function, application of integration, Taylor's and Maclaurin's series, Infinite sequence and series, Partial differentiation, application of partial differentiation and multiple integrals, application of multiple integration etc	Completing ten assignments (2h each)	20	Evaluated based on assignment submission
Online Video based learning	Duration of video = 20h	30	Report or presentation based on learning through

	Report preparation = 10h		video
Online participation in two Quizzes	4 hours for preparation of each quiz and 1 hour for participation in each quiz,	10	Quiz Scores
OnlineCourse (MOOC/NPTEL/SWAYAM/edX, etc.) on Calculus	Minimum course duration of 10 hours	10	Assessment through an examination at the end of the course. Certificate submission required
AI based content development on Subject related topics	5 hours per unit	20	Review based on evaluation of content
Prepare project on Subject related topics	10 hours per project	10	Review based on evaluation of project .
Developing Posters, Charts, or PowerPoint Presentations on Subject related topics	Designing and presenting visual content	20	Assessed based on creativity, clarity, and presentation skills

Guidelines for Faculty:

- The activities listed above are suggestive and faculty members have the flexibility to select and modify them as needed.
- The total self-learning hours remain fixed at 60 hours, ensuring comprehensive coverage of topics of Mathematics -I through at least 3 activities.
- Faculty can adjust the distribution of hours across different activities while maintaining a balanced learning approach.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL
Course / Subject Code: BE01R00051
Course / Subject Name: Basic Electrical Engineering

w. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	ESC

Prerequisite:	NA
Rationale:	Electricity has been the main source of energy for the developing and developed countries. Per capita consumption of electricity of a country can be considered as an indicator of the development of the country. In view of this, it is essential for all engineering graduates to know the basic aspects of electrical engineering. This subject deals with basic circuit solution methods, introduction to electrical machines and basics of domestic electrical installations.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Apply fundamental electrical laws and circuit theorems to electrical circuits.	Application
02	Analyze single phase and three phase AC circuits.	Analyze
03	Describe operating principle and applications of static and rotating electrical machines.	Understand
04	Understand the wiring methods, electricity billing, and working principles of circuits protective devices and personal safety measures.	Read & Understand
05	Understand the electrical safety and purpose, types and scope of earthing systems	Read & Understand

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

**** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**DC Circuits:** Electrical circuit elements (R, L and C), voltage and current independent sources, Kirchoff's current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin and Norton Theorems, Star-delta/Delta-Star conversion, Time-domain analysis of first-order RL and RC circuits.	7	15
2.	**AC Circuits** Representation of sinusoidal waveforms, peak, RMS and average values of different signals, form factor and peak factor, Phasor representation of AC quantities, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), Series and parallel resonances, Three phase balanced circuits, voltage and current relations in star and delta connections, Power measurement in three phase balanced circuits.	9	20
3.	**Magnetic Circuits & Transformers** Magnetic effect of electrical current, cross and dot convention, right hand thumb rule and cork screw rule, Concepts of m.m.f, flux, flux density, reluctance, permeability and field strength, Analogy between electric and magnetic circuits, Magnetic Circuits, B-H Curve, Hysteresis Loop, Hysteresis and Eddy current losses, Construction and working principle of single-phase transformers: Construction, principle of working, voltage and current ratios, losses, definition of regulation and efficiency, Ideal and practical transformer.	8	15
4.	**Fundamentals of Electrical Machines** Generation of rotating magnetic fields, Construction and working of Single-phase induction motors (Split phase, Capacitor start, Permanent split capacitor, Capacitor start/capacitor run). Single phase induction motor applications: pumps, refrigerators, fans, compressors, and portable drills. Construction and working of brushless DC motors and its application: Electrical Vehicle, washing machines, Blowers, Computers/Laptops	9	20

5.	**Electrical Wiring and Installations** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB. Types of lamps, fixtures & reflectors, illumination schemes for domestic, industrial & commercial premises, Lumen requirements for different categories. Earthing – Types of earthing and its importance. Safety precautions for electrical appliances. Types of Batteries, Characteristics of Batteries (Voltage, storage capacity, discharge curve, cycle life). Elementary calculations for energy consumption of home appliances and electricity bill. Basic electrical measurements with Ammeter, Voltmeter, Wattmeter and Energy meter (working principle and circuit connection).	12	30
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40	20	20	20	0	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1) D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
2) Basic Electrical Engineering - Nagsarkar and Sukhija, Oxford University Press
3) B. L. Theraja, "Electrical Technology – Part I and II", S. Chand and Co. 2012
4) D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
5) J. B. Gupta " Basic Electrical Engineering", S.K. Kataria & Sons,2023.
6) A Chakrabarti,S Nath and C K Chanda "Basic Electrical Engineering",TATA McGraw Hill,
7) S.L. Uppal "Electrical Wiring Estimating and Costing", Khanna Publisher, 1987
8) Irving M. Gottlieb ""Practical Electric Motor Handbook"Newnes,1997
9) L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
10) E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
11) V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Open source software and website:

1. https://nptel.ac.in/

Suggested Course Practical List:

1) Introduction of Resistors, Capacitors and Inductors and usage of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope.
2) To verify the Kirchoff's current and Kirchoff's voltage laws.
3) To verify the Thevenin's and Norton's theorems.
4) To verify Superposition's theorems
5) To obtain sinusoidal steady state response of R-L and R-C circuits – impedance calculation and verification phasor relationships between voltage and current and to observe the phase differences between current and voltage phasors
6) To obtain steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in DC input voltage (transient may be observed on a Digital Storage Oscilloscope)
7) To verify the phasor relationships between currents and voltages for resonances in R-L-C circuits
8) To measure the power in three phase balanced circuits using two wattmeter method
9) To verify the current phasor and voltage phasor relationships in three phase star and delta connections
10) Demonstration of cut-section models and charts of various machines
11) Demonstration of domestic switch gears like MCB, ELCB, MCCB etc. of different ratings
12) Understanding of various safety precautions for electrical installations
13) Demonstration of various types of wires, fuses and cables
14) To Calculate energy consumption of various appliances and house hold electricity bills
15) To verify the power factor improvement in single phase AC circuit
16) Study the different types of domestic wiring
17) To obtain Hysteresis loop of a magnetic material on CRO/DSO

List of Laboratory/Learning Resources Required:

Ammeters, Voltmeters, Wattmeters, Resistors, Capacitors and Inductors of appropriate rating. Multimeters, Digital storage oscilloscope, Cut section models/charts of various machines, Demo units for MCB, ELCB, MCCB etc, Samples of wires and cables. Charts for earthing and safety precautions.

- **List of suggested activities for Problem Based Learning:**

No.	Activity Name	Units Mapped	Hours	Brief Description	Evaluation Criteria/Remarks
1	Technical Video-Based Learning	Unit 1, 2, 3	10 (5+5)	Watch curated videos (e.g., NPTEL/MIT OCW) on DC circuits, AC power, Transformers. Submit a reflective report.	Report + Oral Presentation

2	Numerical Assignment Writing	Unit 1, 2, 3	10 (5 × 2h)	Solve 5 numerical assignments covering Theorems, Power factor, AC analysis, and Transformer calculations.	Correctness, method, clarity
3	Simulation & Problem Solving Using Software (Scilab, Tinkercad, LTSpice)	Unit 1, 2, 3	10 (5 × 2h)	Simulate basic circuits (RLC, transformer equivalent), transient analysis, and AC load behavior.	Report + Screenshot + Output sheet
4	Case Study: Domestic Wiring & Electricity Billing	Unit 5	5 (2.5+2.5)	Study household wiring layout and energy bills. Estimate load, usage, and suggest efficiency improvements.	Report + Practical Recommendations
5	Poster / PPT Preparation	Unit 4, 5	4	Topic examples: “BLDC Motor in EV”, “Earthing Methods”, “Difference between MCB & MCCB”	Technical clarity + Visual appeal + Presentation
6	Group Discussion / Seminar on Electrical Safety & Earthing	Unit 5	2	Discuss safety norms, role of protective devices, and earthing types.	Technical depth, articulation
7	Online Technical Quiz / Interactive Simulation (Electrical4U / vlab.co.in)	Unit 1 to 5	2	Attempt at least 3 online quizzes with screenshot of scores and a 100-word learning reflection.	Quiz scores + Reflection Note
8	Maintenance / Troubleshooting Logbook (Lab Based)	Unit 1, 2, 4, 5	2	Record at least 5 issues encountered during lab sessions and how they were resolved.	Clarity of issue, resolution steps
9	Annotated Concept Video (Optional – Higher Bloom’s level)	Unit 2, 3	Extra (Optional 5)	Make a 5–6 minute video explaining topics like phasor relationships or transformer working.	Clarity, technical accuracy, originality

10	Mini Project	Unit 1		1.Design & build a small DC lighting circuit for a room with switches & fuses, calculate load & test functionality. 2. Create a Portable Power Supply 3. Star-Delta Conversion Demonstration Board	1)Students design and wire a small DC circuit with multiple switches and a fuse. 2)Measure total current & voltage at different load configurations. 3) Document calculations & measurements 1)Design and build a small DC power supply (e.g., 6V/12V) using batteries, resistors, and regulators. 2)Test output voltage under varying loads. Mini-Project:Star-Delta Conversion Demonstration Board
11	Mini Project	Unit 2		Construct & test a power factor correction circuit using capacitors for a given inductive load	1) Build a circuit with inductive loads and capacitors to improve the power factor. 2) Measure before and after power factor.
12	Mini Project	Unit 4		Prepare a report on motors used in a household	Identify and document the types

				appliance (e.g., washing machine) and demonstrate working with a model or simulation	& ratings of motors used in 5–6 household appliances. 2)Suggest improvements for energy efficiency.
13	Mini Project	Unit 5		Design a safe, energy-efficient wiring layout for a small house/shop including earthing & protective devices	1.House Wiring Model Design and build a functional model of electrical wiring for a 1-room house with proper earthing & protection devices. 2.Energy Audit & Bill Calculation Measure energy consumption of typical home appliances and calculate monthly electricity bill. Suggest ways to reduce the bill. 3.Safety Demo Board Create a board demonstrating MCB, ELCB, MCCB operation with faulty & safe scenarios.

Unit-Wise Mapping

Unit	Topic	Relevant Activities
1	DC Circuits	Activities 1, 2, 3, 7, 8, 10
2	AC Circuits	Activities 1, 2, 3, 7, 8, 9, 11
3	Magnetic Circuits & Transformers	Activities 1, 2, 3, 9,

4	Electrical Machines	Activities 1, 5, 8,12
5	Electrical Wiring, Safety & Billing	Activities 4, 5, 6, 7, 8,13

Note:

- **All the suggested activity should be related to the subject.**
- **The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.**
- **Rubrics for the evaluation can be prepared by the faculty.**
- **All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.**
- **Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.**

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: UG

Branch: All

Course / Subject Code : BE01R00061

Course / Subject Name : Engineering Graphics & Design

w. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	Engineering Science

Prerequisite:	Zeal to learn the subject
Rationale:	Engineering Drawing is an effective language of engineers. It is the foundation block which strengthens the engineering & technological structure. Moreover, it is the transmitting link between ideas and realization.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Apply the conventions and the methods of engineering drawing also interpret engineering drawings	Application
2	Construct basic and intermediate geometry and comprehend the theory of projection.	Application
3	Dissect the objects in three dimensions with different orientation.	Analyze
4	Make use of computer software for engineering drawings.	Application

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
15	0	30	15	60	02	70	30	20	30	50	200

**** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Engineering Graphics:** Drawing instruments and accessories, BIS – SP 46. Use of plane scales, Diagonal Scales and Representative Fraction.	*	10
2.	**Engineering Curves:** Classification and application of Engineering Curves, Construction of Conics, Cycloidal Curves, Involutes andSpirals	*	10
3.	**Projections of Points and Lines:** Introduction to principal planes of projections, Projections of the points located in same quadrant and different quadrants, Projections of line with its inclination to one reference plane and with two reference planes. True length and inclination with the reference planes.	4	20
4.	**Projections of Planes:** Projections of planes (polygons, circle and ellipse) with its inclination to one reference plane and with two reference planes	2	20
5.	**Projections of Solids, Section of Solids:** Classification of solids. Projections of solids (Cylinder, Cone, Pyramid and Prism) along with frustum with its inclination to one reference plane and with two reference planes, Section of such solids and the true shape of the section.	6	20
6.	**Orthographic Projections:** Fundamental of projection along with classification, Projections from the pictorial view of the object on the principal planes for view from front, top and sides using first angle projection method and third angle projection method, full sectional view.	3	20
7.	**Computer Aided Drawing:** Introduction to AutoCAD, Basic commands for 2D drawing like : Line, Circle, Polyline, Rectangle, Hatch, Fillet, Chamfer, Trim, Extend, Offset, Dim style, etc.	*	
	Total	15	**100**

* Chapter/Topics must be taught during laboratory sessions.

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25	**30**	**30**	**15**	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. A Text Book of Engineering Graphics by P.J.Shah S.Chand & Company Ltd., New Delhi.
2. Elementary Engineering Drawing by N.D.Bhatt Charotar Publishing House, Anand.
3. A text book of Engineering Drawing by R.K.Dhawan, S.Chand & Company Ltd., New Delhi.
4. A text book of Engineering Drawing by P.S.Gill, S.K.Kataria & sons, Delhi.
5. Engineering Drawing by B. Agrawal and C M Agrawal, Tata McGraw Hill, New Delhi.

(b) Open-source software and website:

1. AutoCAD

Suggested Course Practical List:

Students must prepare sketch book and drawing sheets on the following topics.

1. Practice sheet (which includes dimensioning methods, different types of line, construction of different polygon, divide the line and angle in parts, use of stencil) – 2 Hrs.
2. Plane scale and diagonal scale – 2 Hrs.
3. Engineering curves- 4 Hrs.
4. Projection of point and line – 4 Hrs.
5. Projection of plane – 4 Hrs.
6. Projection of solid, section of solid - 4 Hrs.
7. Orthographic projection – 6 Hrs.
8. At least one orthographic drawing (three views) using above mentioned AutoCAD commands. – 4 Hrs.

List of Laboratory/Learning Resources Required:

Suggested Project List:

1. Students must prepare at least one model using cardboard/paper to understand the fundamentals of topic no. 1 to 6. This project work will be considered for practical evaluation.

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5hrs., Report preparation = 5hrs. Total = 10hrs.	Based on report submitted. Report should contain observations and calculations

			based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 4hrs. each. Total = 20hrs.	Based on the correctness of submittedassignment.
4.	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB,modeling and Analysis software or any other software	5 small coding-based assignment of 2hrs. each. Total = 10hrs.	Based on the coding solution submitted.
5.	Self-learning online course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10hrs.	Based on the depth of the solution submitted.
7	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on quiz/report submitted
8	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20 hrs.	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 hrs.	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 hrs. Non- working = 8 hrs.	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15 hrs. for industrial exposure Problem identification and tentative solution = 10 hrs. Total = 20 hrs.	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = Min. 1 hr.per subject. Max. 3 hrs. per subject	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-	Duration of data collection/study =	Based on in-depth study,

	based learning	5hrs. Report preparation = 5hrs. Total = 10hrs.	technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 hrs.	Depending on the complexity of the Application/Software
15.	Research paper publication	Duration = 10 hrs.	Based on submission of proof of publication
16.	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10 hrs.	Based on the performance of the equipment
17.	Expert lecture/session	Duration 3 hrs. For attending the lecture/session– 2 hrs. and for report writing 1 hr.	Based on the proof of attendance and report submitted
18.	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
19.	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: ALL

Course / Subject Code : BE01R00071

Course / Subject Name : Design Thinking

W. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	ESC

Prerequisite:	**NIL**
Rationale:	This course is designed for students from all disciplines who seek to understand design thinking for brand, product, and service development. It covers essential concepts, methods, and techniques of design thinking, empowering students to drive innovation in both business and the social sector.

Course Outcome:

After Completion of the Course, the Student will be able to:

No	Course Outcomes	RBT Level
01	Understand the fundamental principles and importance of Design Thinking in fostering innovation and its relevance in engineering.	UN
02	Apply systematic problem identification, problem framing-articulation, and problem-solving approaches in the context of Design Thinking.	AP
03	Analyze and evaluate different tools and methodologies used in Design Thinking, such as observation, ethnographic research, and mind mapping, to gain insights into user unmet needs.	AN
04	Develop and refine product concepts by preparing product development canvases (PDC) that consider product experience, functions, features, and components. (Synthesis level)	AP
05	Create a final working prototype or an alternative prototype for projects with limitations, showcasing the functionality and features, Viability, Impact, Sustainability, Scalability, Costing, and Resources for the Creation	CR

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
00	00	60	00	60	02	00	00	20	00	80	100

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Design Thinking for Engineers** What Sets Design Thinking Apart? Essential Design Thinking Skills, Core Principles of Design Thinking, Foundations of Design Thinking, Building an Effective Design Thinking Team, Design Thinking Workshops and Meetings Exercises and Case-Based Discussions	08	13
2.	**Stages of the Design Thinking Approach** Class Exercise: Review the Case Study **Observation:** Role of observation in understanding product and process challenges, Techniques for effective product and process observation **Exercise:** Based on the AEIOU Framework **Empathize** with Customers/Users **Exercise:** Engage with Customers/Users **Define the Problem,** Exercise: Review and Follow-Up, Define the Point of View **Ideate** Exercise: Develop Potential Solutions **Prototype Alternate Solutions** Exercise: Create a Prototype of the Solution **Test the Solutions** Exercise: Prepare and Conduct Tests of the Prototype and Solution	14	23

	Exploring Design Thinking in Innovation: Understanding the Role of Design Thinking in Product and Process Innovation, Differentiating Engineering Design and Design Thinking Contrasting Approaches: Engineering Design vs. Design Thinking Stanford Design thinking process and Double Diamond model		
3.	**Design Thinking Techniques** Understanding Listening and Empathizing Techniques: Exploring observation methods, Utilizing a structured, open-ended approach for effective communication, Ideation Tools: Brainstorming techniques for idea generation, Applying innovation heuristics to foster creativity. **Introduction to SCAMPER technique:** Explanation of SCAMPER (Substitute, Combine, Adapt, Modify, put to another use, Eliminate, Reverse) and its application in diverse innovation contexts (product, system, process) Practical exercises and case studies demonstrating SCAMPER's effectiveness in idea generation Prototype and Test Techniques: Type of Prototype (PoC), Forms of testing in Design Thinking, Prepare and A/B Test of the prototype	14	23
4.	**Methods and Tools for Design Thinking Practice** Empathize: Ask five why questions, Empathy map, storytelling, critical items diagram, mind map, journey map Ideate: Brainstorming, 2X2 matrix, NABC Methods Prototype: Exploration map, Minimum Viable Product (MVP), Feasibility Testing, Viability Testing, Sustainability Testing Test: Collet Feedback, iterate and improve the ideas	14	23
5.	**Adopt and Adapt Design Thinking** Cautions and Pitfalls: Assumptions Exercise: Assumptions Pitfalls and Cautions in Design Thinking Workgroups Application of Design Thinking in Academic Projects Across Disciplines	10	18
	Total	**60**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
0	**15**	**40**	**15**	**20**	**10**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Pavan Soni (2020), Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Penguin Random House India Private Limited
2. Gasparini, Andrea. "Perspective and use of empathy in design thinking." In ACHI, the Eight International Conference on Advances in Computer-Human Interactions, pp. 49-54. 2015.
3. Defining a Problem Statement — Design Thinking by Priyanka Jeph in QED42
4. Scamper: How to Use the Best Ideation Methods by Rikke Friis Dam and Teo Yu Siang in Interaction Design Foundation
5. Design: Creation of Artifacts in Society by Prof. Karl Ulrich, U. Penn
6. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation."
7. Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, "Design Thinking for the Greater Good: Innovation in the Social Sector."

(b) Open-source software and website:

1. Google Workspace: Docs, Sheets, & Slides
2. Google Jamboard
3. Storyboard
4. Any other Relevant Tools

(c) Suggestive MOOC Course

1. B.K. Chakravarthy, Design Technology and Innovation, SWAYAM NPTEL (Online)
2. B.K. Chakravarthy, Innovation by Design, SWAYAM NPTEL (Online)
3. Nina Sabnani, Understanding Design, SWAYAM NPTEL (Online)
4. R T Krishnan and V Dhabolkar, Managing Innovation, SWAYAM NPTEL (Online)

Note:

1. Based on Design Thinking, individual BoS may propose mini projects in the relevant subject in higher semesters.

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: UG

Branch: All

Course / Subject Code : BE01R00081

Course / Subject Name : Basic Mechanical Engineering

w. e. f. Academic Year:	2024-25
Semester:	1st Year
Category of the Course:	ESC

Prerequisite:	Nil
Rationale:	Knowledge of basic principles of Mechanical Engineering is required in various fields of engineering.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Explain the various sources of energy and basic terminology of Mechanical engineering	Understand
2	Make calculations for commonly used working fluids i.e. ideal gases and steam	Apply
3	Make use of various heat engine cycles and explain construction and working of IC engines	Apply
4	Explain working and applications of steam boilers and various energy conversion systems	Understand
5	Explain various power transmission elements, construction and working of various clutches; couplings and brakes, and properties of various engineering materials with their applications	Understand

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Basic Terminology and Energy:** Prime movers and its types, Concept of Force, Pressure, Energy, Work, Power, System, Heat, Temperature, Specific heat capacity, Process, Cycle, Internal energy, Enthalpy, Statements of Zeroth law and First law Applications of Energy sources like Fossil fuels, Nuclear fuels, Hydrogen fuel, Hydro, Solar, Wind, and Bio-fuels, Environmental issues like Global warming and Ozone depletion	8	14
2.	**Properties of gases:** Boyle's law, Charles's law, Gay-Lussac's law, Avogadro's law, Combined gas law, Gas constant, Relation between cp and cv, Various non-flow processes like constant volume process, constant pressure process, Isothermal process, Adiabatic process, Polytropic process **Properties of Steam:** Steam formation, Types of steam, Enthalpy, Specific volume, Internal energy and dryness fraction of steam, use of steam tables, steam calorimeters	12	22
3.	**Heat Engines:** Heat engine cycle and Heat engine, working substances, Classification of heat engines, Description and thermal efficiency of Carnot; Rankine; Otto cycle and Diesel cycles **Internal Combustion Engines:** Introduction, Classification, Engine details, four-stroke/ two-stroke cycle Petrol/Diesel engines, Indicated power, Brake Power, Efficiencies	10	20
4.	**Steam Boilers:** Introduction, Classification, Cochran, Lancashire and Babcock and Wilcox boiler, Functioning of different mountings and accessories	-	10
5.	**Air compressors and pumps:** Types and operation of Reciprocating and Rotary air compressors, significance of Multistage, Types and operation of Reciprocating, Rotary and Centrifugal pumps, Priming	6	10
6.	**Refrigeration & Air Conditioning:** Refrigerant, Vapor compression refrigeration system, Vapor absorption refrigeration system, Domestic Refrigerator, Window and split air conditioners	4	8

7.	**Couplings, Clutches and Brakes:** Construction and applications of Couplings (Box; Flange; Pin type flexible; Universal and Oldham), Clutches (Disc and Centrifugal), and Brakes (Block; Shoe; Band and Disc) **Transmission of Motion and Power:** Shaft and axle, Different arrangement and applications of Belt drive; Chain drive; Friction drive and Gear drive	-	10
8.	**Engineering Materials:** Types, properties and applications of Ferrous & Nonferrous metals, Timber, Abrasive material, silica, ceramics, glass, graphite, diamond, plastic and polymer	5	6
	Total	**45**	**100**

Note: Topic No. 4 and 7 of the above syllabus must be covered in Practical Hours.

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**40**	**40**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Elements of Mechanical Engineering by N M Bhatt and J R Mehta, Mahajan Publishing House
2. Basic Mechanical Engineering by Pravin Kumar, Pearson Education
3. Fundamental of Mechanical Engineering by G.S. Sawhney, PHI Publication New Delhi
4. Elements of Mechanical Engineering by Sadhu Singh, S. Chand Publication
5. Introduction to Engineering Materials by B.K. Agrawal, McGraw Hill Publication, New Delhi

(b) Open source software and website:

1. https://nptel.ac.in
2. www.vlab.co.in

Suggested Course Practical List:

1. To understand construction and working of various types of boilers.
2. To understand construction and working of different boiler mountings and accessories.

3. To understand construction features of two/four stoke petrol/diesel engines
4. To determine brake thermal efficiency of an I. C. Engine.
5. To understand construction and working of different types of air compressors.
6. To demonstrate vapor compression refrigeration cycle of domestic refrigerator OR window air conditioner OR split air conditioner.
7. To understand construction, working and application of clutches, couplings and brakes
8. To understand different arrangement and application of various power transmission drives

List of Laboratory/Learning Resources Required:

Models of Cochran, Lancashire and Babcock and Wilcox boilers, models of various mountings and accessories, Models of various types of IC engines, Single cylinder two stroke /four stroke petrol/ diesel engine, models of pumps, compressors, Domestic refrigerator/window air conditioner/split air conditioner, models of various types of brakes, coupling, clutches, drives

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5hrs., Report preparation = 5hrs. Total = 10hrs.	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 4hrs. each. Total = 20hrs.	Based on the correctness of submitted assignment.
4.	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB,modeling and Analysis software or any other software	5 small coding-based assignment of 2hrs. each. Total = 10hrs.	Based on the coding solution submitted.
5.	Self-learning online course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10hrs.	Based on the depth of the solution submitted.
7	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on quiz/report submitted
8	Technical paper reading and summarization of research papers	5 research papers = 20 hrs.	Summarize research paper and evaluation critical parameters

	based on relevant subject		
9.	Poster/chart/power point preparation on technical topics	Duration = 6 hrs.	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 hrs. Non- working = 8 hrs.	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15 hrs. for industrial exposure Problem identification and tentative solution = 10 hrs. Total = 20 hrs.	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = Min. 1 hr.per subject. Max. 3 hrs. per subject	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 hrs.	Depending on the complexity of the Application/Software
15.	Research paper publication	Duration = 10 hrs.	Based on submission of proof of publication
16.	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10 hrs.	Based on the performance of the equipment
17.	Expert lecture/session	Duration 3 hrs. For attending the lecture/session– 2 hrs. and for report writing 1 hr.	Based on the proof of attendance and report submitted
18.	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
19.	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: ALL

Course / Subject Code : BE01R00111

Course / Subject Name : Basic Electronics Engineering

w. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	ESC

Prerequisite:	**High School Physics and Mathematics**
Rationale:	Electronics is playing a key role in all engineering applications. All engineers should have the basic knowledge of electronics. Purpose of this course is to make students familiar with basic electronic devices, circuits and their applications. Students will be able to operate electronic test and measurement equipment like digital multi-meter, CRO, DC power supply and function generator.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Analyze the general and special purpose diode circuits	N
02	Design biasing circuits for BJT and FET	C
03	Analyze BJT circuits in small-signal domain	N
04	Analyze FET circuits for DC voltages and currents	N
05	Understand usage of Special Purpose Diodes	U

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: ALL

Course / Subject Code : BE01R00111

Course / Subject Name : Basic Electronics Engineering

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Semiconductor Diodes:** p-n junction diode, Characteristics and parameters, Diode approximations, DC load line analysis, Temperature effects, Diode AC models, Diode specifications, Diode testing, Zener diodes.	6	15
2.	**Diode Applications**: Half-wave and Full-wave rectifiers, Power supply, RC and LC power supply filters, Zener diode voltage regulators, Series and shunt clipping circuits, Clamping circuits, DC voltage multipliers.	6	15
3.	**Bipolar Junction Transistors** : BJT operation, BJT voltages and currents, BJT amplification, BJT switching, CB, CE and CC characteristics, Transistor testing.	6	15
4.	**BJT biasing** : DC load line and bias point, Base bias, Collector-to-base bias, Voltage- divider bias ,Comparison of basic bias circuits, Bias circuit design.	6	15
5.	**AC analysis of BJT circuits** : Coupling and bypass capacitors, AC load lines, transistor models and parameters, CE circuit analysis, CE circuit with unbypassed emitter resistor, CC circuit analysis, CB circuit analysis, Comparison of CE, CB and CC circuits	6	15
6.	**Field Effect Transistors**: Junction Field Effect Transistors, JFET characteristics, JFET data sheets and parameters, FET amplification and switching, MOSFETs	5	10
7.	**FET biasing** : DC load line and bias point, Gate bias, Self bias, Voltage divider bias, Comparison of basic JFET bias circuits	4	5
8.	**Special Purpose Diodes**: Light Emitting Diode(LED), Photo diode, Solar cell, PIN diode, Varactor diode, Schottky diode, Tunnel diode, Seven segment display	6	10
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**20**	**25**	**30**	**0**	**10**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth Edition
2. Jacob Millman, Christos Halkias, Chetan D. Parikh, "Integrated Electronics", Tata McGraw Hill, Second Edition

Open source software and website:

1. http://nptel.ac.in/courses/122106025 (Basic Electronics and lab by Prof. T.S.Natarajan)

Suggested Course Practical List:

1. VI characteristics of p-n junction diode, LED and photo diode
2. Half wave and full wave rectifier circuits
3. Clipper and clamper circuits
4. Zener diode regulator circuit
5. CE amplifier characteristics
6. CB amplifier characteristics
7. CC amplifier characteristics
8. Transistor as a switch
9. Voltage gain and current gain of a CE amplifier
10. FET characteristics
11. Varactor diode and tunnel diode characteristics
12. Seven segment LED operation

List of Laboratory/Learning Resources Required: CRO, Function Generators, DC power supply, bread board and discrete electronic components

Suggested Project List: Project based on design of a small circuit with input and output signal observations on CRO.

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning	Duration of video =	Report /presentation based on

	related to the subject	5h Report preparation = 5h Total = 10h	the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h	Based on in-depth study, technical depth, data collected,

		Report preparation = 5h Total = 10h	fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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w. e. f. Academic Year:	2024-25
Semester:	1st Year
Category of the Course:	ESC

Prerequisite:	• Basic Computer Skills • Logical Thinking and Problem-Solving Abilities • Understanding of mathematical logic and problem-solving strategies
Rationale:	The "Programming for Problem Solving" course is a foundational skill that significantly enhances an engineer's problem-solving abilities, career prospects, and capacity for innovation. Integrating programming into the curriculum ensures that engineering programs prepare students to meet the challenges of the modern technological landscape and contribute effectively to their respective fields.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Identify fundamental programming constructs such as variables, data types, operators, expressions, control structures, functions and basic data structures	Remember
02	Explain the principles of programming and software development, including the structure and operation of algorithms, flowcharts, and pseudocode.	Understand
03	Develop simple programs using appropriate data structures and standard libraries.	Apply
04	Apply programming constructs such as loops, conditional statements, and functions to solve basic engineering problems.	Apply
05	Debug and troubleshoot programming errors by systematically testing and refining code.	Analyze

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
30	00	60	30	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Programming** • **Basics of Computers**: Overview of computer systems, hardware, andsoftware. • **Introduction to Programming Languages**: Types of programminglanguages, language translators (compilers, interpreters). • **Flowcharts and Algorithms**: Basics of creating flowcharts and writingalgorithms for problem-solving.	03	10
2.	**Basics of C Programming** • **Structure of a Program**: Basic syntax, semantics, and structure of C programs. • **Data Types and Variables:** Primitive data types, variables, and constants. • **Operators:** Arithmetic, relational, logical, bitwise, and assignment operators.	03	10
3.	**Control Structures** • Conditional Statements: if, if-else, nested if-else, switch-case. • Loops: for, while, do-while loops. • Break and Continue Statements: Usage in loop control.	03	10
4.	**Functions and Modular Programming** • Defining Functions: Syntax, return types, and parameter passing. • Library Functions: Standard library functions and header files (for C). • Recursion: Basic concepts and examples.	03	10
5.	**Arrays and Strings** • Arrays: One-dimensional and multi-dimensional arrays, array operations.	03	10

	• Strings: String handling functions, basic string operations.		
6.	**Pointers** • Pointers: Basics of pointers, pointer arithmetic, pointers and arrays, pointers tofunctions (for C).	03	10
7.	**Structures and Unions** • Structures: Defining and using structures, array of structures, pointer tostructures. • Unions: Basics and usage.	03	10
8.	**File Handling** • File Operations: Opening, closing, reading, writing files. • File Pointers: File pointers and basic file operations (for C).	03	10
9.	**Dynamic Memory Allocation** • Memory Allocation: malloc, calloc, realloc, and free functions. Usage and examples.	03	10
10.	**Debugging and Testing** • Debugging Techniques: Common debugging practices, use of debugging tools. • Testing: Writing test cases, unit testing.	03	10
	Total	**30**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	20	40	20	00	00

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as perRevisedBloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. C Programming Language by Brian W. Kernighan and Dennis M. Ritchie**,** Latest Edition (for C programming)
2. Let Us C by Yashavant Kanetkar, Latest Edition (for C programming)
3. Problem Solving and Program Design in C by Jeri R. Hanly and Elliot B. Koffman**,** Latest Edition **(**for Cprogramming)

(b) Open-source software and website:

1. OnlineGDB : GDB online Debugger | Compiler - Code, Compile, Run, Debug online C, C++ (onlinegdb.com)
2. Compiler Explorer (Godbolt): Compiler Explorer (godbolt.org)
3. JDoodle: JDoodle - Free online cloud coding platform IDE to practice, teach and learn programming

Suggested Course Practical List:

1. Write a program that performs basic arithmetic operations (addition, subtraction, multiplication, and division)and demonstrates the use of different data types.
2. Create a program that uses if, else, and switch statements to implement a simple menu-driven application. Useloops (for, while, and do-while) to repeat tasks.
3. Develop a program that calculates the factorial of a number using both iterative and recursive functions.
4. Write a program to perform various operations on arrays (e.g., sorting, searching) and strings (e.g.,concatenation, comparison).
5. Implement a program that uses pointers to create and manipulate dynamic arrays, demonstrating the use of malloc, calloc, realloc, and free.
6. Design a student record system using structures that store and display information such as name, roll number,and grades.
7. Write a program to read from and write to files, such as creating a simple text editor that performs basic fileoperations.
8. Implement a singly linked list with operations like insertion, deletion, and traversal.
9. Develop programs to simulate stack operations (push, pop, peek) and queue operations (enqueue, dequeue)using arrays and linked lists.
10. Provide students with a program containing intentional errors and inefficiencies. Have them use debuggingtools (like gdb) to find and fix the errors and optimize the code for better performance.

List of Laboratory/Learning Resources Required:

1. Computer System/Laptop with latest configurations.
2. Internet Connectivity

Suggested Project List:

1. **Library Management System** with the Objectives of
   - Practice basic C syntax and operations,
   - Use control structures effectively,
   - Implement functions and modular programming,
   - Manipulate arrays and strings,
   - Handle file operations for data storage and retrieval

2. **Institute Hall Management System,** Project Objectives:
   - To manage the allocation of halls for different events.
   - To maintain records of bookings, cancellations, and availability of halls.
   - To provide an interactive user interface for managing hall reservations.

Suggested Activities for Students:

- To enhance the programming skills of students in a C Programming and Problem-Solving course, the instructor can assign various activities that progressively build their understanding and ability to applyconcepts.

- **List of suggested activities for Problem Based Learning::**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem.	Based on the depth of the

		Study of the problem and solution finding, Total = 10h	solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Degree

Branch: All

Course / Subject Code : BE01R00141

Course / Subject Name : Universal Human Values

w. e. f. Academic Year:	2024 - 2025
Semester:	Ist Year
Category of the Course:	HSMC-01

Prerequisite:	Basic understanding of UHV-I from induction program
Rationale:	The Universal Human Values (UHV) course is designed to foster a deeper understanding of the values and principles that are essential for holistic human development by harmonizing with self, family, society, nature and for the global peace at large. The course also encourages students to explore and internalize universal values, such as respect, affection, care, guidance, reverence, glory gratitude and love. So, the course aspires to create a foundation for a harmonious and just society by empowering individuals with the wisdom and values necessary for sustainable meaningful living and promoting the idea of वसुधैव कु टुम्बकम.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Understand and explore the content of value education and human values	**A**
02	Develop a universal approach for self-awareness with correct understanding of reality through the process of self-exploration.	**E**
03	Inculcate mature understanding for individual's role and responsibility towards family.	**E**
04	Strengthen interpersonal relationships, sustainability and commit individual's role to society.	**E**
05	Understand required skills to explore the laws of nature for global harmony	**E**

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
30	00	00	30	60	02	70	30	00	30	00	130

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Degree

Branch: All

Course / Subject Code : BE01R00141

Course / Subject Name : Universal Human Values

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Unit 1: Introduction to value education & human values** 1. Concept, Need and Role of Value Education and Human Values 2. Role of Education in Holistic Development 3. Methods to Satisfy Basic Human Aspirations 4. Basic human aspirations and their fulfillment through value education. 5. The importance of values in decision-making 6. Fundamental universal human values (e.g., truth, love, peace, justice, compassion, etc).	5	15
2.	**Unit 2: Harmony with self** 1. Importance of self-awareness: Self reflection 2. Who am I? – Imagination & Action 3. Understanding & exploring needs of self and body 4. Self -Exploration – A Process of Fundamental Human Desires – Happiness, Peace and Contentment for Material, Behavioral and Intellectual well Being 5. Holistic understanding of mind & body 6. Famous anecdote and relevant case studies.	5	20
3.	**Unit 3: Harmony with family** 1. Basic unit of human interaction – The Family 2. Importance of happy relations/connections in family 3. Foundational value: Respect, Affection, Care, Guidance, Reverence, Glory, Gratitude, Love 4. Famous anecdote and relevant case studies.	5	15
4.	**Unit 4 Harmony in the Society** 1. Understanding Harmony in society and universal human order. 2. Goal of human being living in the society 3. Foundation of Human society: roles of social institutions and impact of societal values. 4. Community building through contributions - trust and cooperation, Community building, social cohesion, equality and social justice 5. Diversity and inclusivity - understanding and Valuing diversity, promoting respect and inclusivity, resolving conflict to build a culture of peace. 6. Famous anecdote and relevant case studies	5	15
5.	**Unit – 5 Harmony with Nature**	5	15

	1. Understanding Co-existence with Nature 2. Interdependence of all Living Being and Non-Living Being 3.Environmental Ethics 4. Harmony in Sustainability 5. Understanding and exploring four orders of nature: Physical Order, Pranic Order, Animal Order, Human Order 6. Famous anecdote and relevant case studies		
6.	**Unit 6 - Harmony for Global peace** 1. Understanding global peace 2. Concept of वसुधैव कु टुम्बकम- one earth one family 3.Fostering Universal brotherhood and unity, collaborative problem solving, respecting cross cultural communication 4.Famous anecdote and relevant case studies	5	20
	Total	**30**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
22	22	22	17	17	--

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Gaur R. R., Asthana R., Bagaria G. P., *The Textbook A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Gaur R. R., Asthana R., Bagaria G. P., *The Teacher's Manual Teachers' Manual for A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2
3. Nagaraj A., *JeevanVidya: EkParichaya*, Jeevan Vidya Prakashan, Amarkantak, 1999.
4. Tripathi A. N., *Human Values*, New Age Intl. Publishers, New Delhi, 2004.
5. Sadhguru, *Relationship: Bond or Bondage*, Jaico Publishing House, Mumbai, 2018
6. Sadhguru, *Inner Engineering: A Yogi's guide to Joy*, Penguin Ananda, 2016
7. Kalam A. P. J. and Tiwari Arun, *Wings of Fire – An Autobiography*, University Press Pvt. Ltd., Hyderabad, 2000

8. Gandhi Mohandas Karamchand, *The Story of My Experiments with Truth,* Fingerprint Publishing, 2011
9. Nagraj A, *Vyavharwadi Samajshastra (Behavioral Sociology),* Jeevan Vidya Prakashan, Amarkantank, 2009

(b) Open source software and website:

1. https://drive.google.com/drive/folders/1bmdlHoXAGRfZDM-16yrwnbd7YwqLGXsb?usp=drive_link (Suggested anecdotes, short stories, case studies, links and other relevant material for Unit 2,3,4,5 and 6 are available in this link for your reference.)

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Identify one habit to be transformed and ask student to execute it for 21 days	Activity duration =21 day. Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
2	Track social media usage: Decide one social media app to be uninstalled from your phone for 15 days.	Activity duration =15 day. Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
3	To do seva activities at old age home, orphanage home, ,hospital, Cleanliness at school,society,college	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
4	Prepare a chart of famous failures.	Duration = 5 hours	Based on report /Chart/Poster/Presentation submitted
5	Make a team of 2-3 members .Plan the overall activities to be carried out for tech fest at your college, Make detailed list of activities to be done and budget plan.	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
6	Introspect and identify at least five scenario where you feel that your actions could be updated based on learning from listening and understanding	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
7	Sit with your family for 15 minutes a day discuss and share each other's activities(for Total 20 days)	Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
8	A well-organized plan for managing a **college tech fest** with a **team of 2–3 members**, including a **detailed list of**	Duration =5 hour	Based on report submitted.

	activities and a **budget plan**.		
9	Sitting with your family for just **15 minutes a day** share each other's activities	Activity time = 5 hours (20 days) Report time = 5 hours	Based on report /Chart/Poster/Presentation submitted.
10	Group discussion: *What do I owe to my parents?* Write a Gratitude Letter to a parent/sibling/friend.	Duration= 1 hour	Based on report /Chart/Poster/Presentation submitted.
11	Prepare a "Personal Vision Statement" or "My Code of Living" booklet	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted.
12	Role-play or skit on miscommunication in relationships and solutions	Duration = 1 hour	Based on report /Chart/Poster/Presentation submitted
13	Community Seva (Service Activity): cleaning, helping elderly, teaching kids, etc. + reflection	Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
14	Self-Observation Diary: Record thoughts/emotions/actions for 10 days.	Duration = 1 hour	Based on report /Chart/Poster/Presentation submitted
15	Life Vision Journal: Write your 5-year vision—career, health, relationships, contribution. "My Life Compass" Poster: Personal motto, core values, role models, goals.	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
16	Avoid all social media for 24 hours. Reflect: *What did I miss? What did I gain?*	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
17	Review and clean your social media: Unfollow toxic or negative accounts. Follow value-based, positive pages. Reflect: *What did I miss? What did I gain?*	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
18	Maintain a log of daily screen/social media usage for 3–5 days. Categorize it into productive vs unproductive time.	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
19	Organize a physical or virtual tour to a local museum, heritage site, or historical monument.	Duration = 5 hour	Based on report /Chart/Poster/Presentation submitted
20	Students create weekly factsheets or digital posts sharing unknown facts from India's past (science, ethics, literature, and education).	Duration = 5 hour	Based on report /Chart/Poster/Presentation submitted

21	Watch a documentary (e.g., *Bharat Ek Khoj*, *Science in Ancient India*) and write a reflection on what surprised or inspired them.	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: All
Subject Code: BE01R00151
Subject Name: Contributor Personality Development Program

w. e. f. Academic Year:	2024 - 2025
Semester:	Ist Year
Category of the Course:	HSMC-01

Type of course: Work-Personality Development

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability tonavigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
30	00	00	30	60	02	70	30	00	30	00	130

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Note:

- Classroom facilitated sessions are planned which include Solutioning and Self- discovery sessions.
- In addition, there will be individual/ team projects as part of Practicals. Students can do this on their own, with faculty as guide.

Note:

It is the responsibility of the institute heads that marks for PA of theory & ESE and PA of practical for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

Content:

Sr. No.	Content	Total Hrs.
1.	**The Contributor Work Ideal** In this topic, students explore what is their "ideal" of work - is the ideal to be a "worker" or to be a "contributor"? For example, an employee who has the ideal of a "worker" goes to work to pass time, earn a living, get benefits; in contrast to an employee with the ideal of a "contributor" who wants to make a difference, get things done well, create value for the company. This enables students to transform their expectation of themselves in work	5
2.	**Identity & Self-esteem** In this topic, students engage with the question "who am I?" or on whatbasis do they define themselves. Is their identity defined by what others think of them (extrinsic self-esteem) or by what they think of themselves (intrinsic self-esteem)? Further, they discover positive identities that lead to intrinsic self-esteem, such as an I-can identity based on one's capacity and inner strength. This enables them to build confidence and self-esteem.	5

3.	**Become a Creator of one's destiny** In a "victim stance", we see the career environment as full of difficultiesand hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the "creator of destiny stance" to challenges and situations. This stance frees them to try out new things, open up new possibilities, take on responsibility, see the opportunity hidden in their environment.	5
4.	**Achieving Sustainable Success** In this topic, students discover how to achieve sustainable or lasting success, by building one's "engine of success", making them success-worthy. Where their focus shifts to building one's "engine of success" rather than being on chasing the "fruits of success". This is important, because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success, fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don't come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not. And with a strong engine of success, fruits come to them in time.	5
5.	**Career Development Models** In this topic, students explore a range of diverse "career development models" and the possibilities for contribution each opens up to them (e.g. start-up career model, change-maker career model, etc.). This opens their mind to different and even unconventional career models possible, beyond the usual (such as "stable large company career model" where one gets an engineering degree, then MBA, then get a job in a large company). This frees them from a herd mentality when makingcareer choices.	5
6	**Expanding contribution in every role** In this topic, students explore the many roles they can play in their life & discover the power they have to expand the contribution possible in any role. (E.g. role of student, role of manager, role of a project site engineer). So, the potential of a role is in the individual's hands. This opens their mind to an alternative way of career growth.	5
	Total Hours	**30**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (for B.Pharm)					
R Level	U Level	A Level	N Level	E Level	C Level

-	**15**	**20**	-	**25**	**20**

Distribution of Theory Marks (for B.E., Diploma, MCA)					
R Level	U Level	A Level	N Level	E Level	C Level
-	**15**	**15**	-	**20**	**20**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Createand above Levels (Revised Bloom's Taxonomy)

Reference resources:

A. Basic reference for both students and teachers

1. Contributor Personality Program textbook cum workbook developed by Illumine.
2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

B. Advanced reference for teachers

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan,1989
3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya VidyaBhavan
4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group,2007
8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful

Work, TadWaddington; Agate Publishing, 2007
9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, IanAyres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); ErikStern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review;Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, HowardGardner; John Wiley & Sons, 2007

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
Outcome of theory sessions		
CO-1	Students will be able to recognize & appreciate two alternative ideals of work – ideal of a "worker" and ideal of a "contributor". And why organizations of todayexpect people they employ to be contributors and not just workers.	10-12%
CO-2	Students will be able to recognize & appreciate alternative ways in which they could define themselves or "who am I" (their identity) – and which are positive identities that will lead to building intrinsic self-esteem and confidence in oneself; in contrast to identities that will lead to extrinsic self-esteem that makes them more dependent on their environment.	10-12%
CO-3	Students will be able to recognize & appreciate a "victim" stance as distinct froma "creator of destiny" stance in the way people approach challenges and situations; and how the latter frees individuals to take on challenges and open up opportunities.	10-12%
CO-4	Students will be able to differentiate between two alternative approaches to success - 'building one's engine of success' and 'chasing the fruits of success'; they also appreciate the payoffs/ consequences of both and which is more likely to lead to sustainable or lasting success in the long run.	10-12%
CO-5	Students will be able to recognize & appreciate different career models and their value; to help them make more informed career-related choices.	10-12%

CO-6	Students will be able to recognize & appreciate how one can expand the contribution possible in any role, thereby opening up an alternative way of career growth to them.	10-12%
Outcome of practical sessions		
CO-7	Students learn to re-interpret their life and college experiences to showcase their contribution affinities which are relevant for employers.	15%
CO-8	Students learn to apply contributor thinking to real-world or career relevant challenges.	15%

- **List of suggested activities for Problem Based Learning:**

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3	To do seva activities at old age home, orphanage home, ,hospital, Cleanliness at school,society,college	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
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8	A well-organized plan for managing a **college tech fest** with a **team of 2–3 members**, including a **detailed list of activities** and a **budget plan**.	Duration =5 hour	Based on report submitted.
9	Sitting with your family for just **15 minutes a day** share each other's activities	Activity time = 5 hours (20 days) Report time = 5 hours	Based on report /Chart/Poster/Presentation submitted.
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19	Organize a physical or virtual tour to a local museum, heritage site, or historical monument.	Duration = 5 hour	Based on report /Chart/Poster/Presentation submitted
20	Students create weekly factsheets or digital posts sharing unknown facts from India's past (science, ethics, literature, and education).	Duration = 5 hour	Based on report /Chart/Poster/Presentation submitted
21	Watch a documentary (e.g., *Bharat Ek Khoj*, *Science in Ancient India*) and write a reflection on what surprised or inspired them.	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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w. e. f. Academic Year:	2025 - 2026
Semester:	Ist Year
Category of the Course:	HSMC-01

Type of Course –

Value-based holistic personality development course for university students.

Rationale

IPDC aims to prepare students for the modern challenges they face in their daily lives. Promoting fortitude in the face of failures, unity amongst family discord, self-discipline amidst distractions, and many more priceless lessons. The course focuses on morality and character development at the core of student growth, to enable students to become self-aware, sincere, and successful in their many roles - as an ambitious student, reliable employee, caring family member, and considerate citizen.

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
30	00	00	30	60	02	70	30	00	30	00	130

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

The assessments should include both continuous evaluation and end-of-semester examinations. The assessment scheme should include student attendance, assignments, mid-term exams, viva, workbook submission, and end-of-semester examinations.

Course-Content:

Each lecture can be taken in a continuous two-hour session, or in two separate one-hour sessions. In addition to the core lectures, an induction and concluding lectures are recommended as shown in the below table.

Lecture No.	Module -Lecture	Lecture Description	Hours
Induction	The Need for Values	Students will learn about the need for values as part of their holistic development to become successful in their many roles - as ambitious students, reliable employees, caring family members, and considerate citizens.	2
1	**Remaking Yourself** Restructuring Yourself	Students learn how self-improvement enables them to secure a bright future for themselves. They will learn 6 powerful thought-processes that can develop their intellectual, physical, emotional, and spiritual quotients.	2
2	**Remaking Yourself** - Power of Habit	Students will undergo a study of how habits work, the habits of successful professionals, and the practical techniques that can be used to develop good habits in their life.	2
3	**Learning from Legends-** Tendulkar & Tata	Students will learn from the inspirational lives of India's two legends, Sachin Tendulkar and Ratan Tata. They will implement these lessons through relatable case studies.	2
4	**From House to Home-** Listening & Understanding	Active listening is an essential part of academic progress and communications. Students will learn to listen with their eyes, ears, mind, and heart.	2
5	**Facing Failures-** Welcoming Challenges	This lecture enables students to revisit the way in which they approach challenges. Through the study of successful figures such as Disney, Lincoln and Bachchan, students will learn to face difficulties through a positive perspective.	2
6	**Facing Failures-** Significance of Failures	Failure is a student's daily source of fear, negativity, and depression. Students will be given the constructive skills to understand failure as formative learning experiences.	2
7	**My India My Pride-** Glorious Past - Part 1	India's ancient Rishis, scholars, and intellectuals have made tremendous contributions to the world, they developed an advanced, sophisticated culture and civilization which began thousands of years ago. Students will learn the importance of studying India's glorious past so that they could develop a strong passion and pride for our nation.	2

8	**My India My Pride-** Glorious Past - Part 2	Our ancient concepts can be used to seek revolutionary ideas and to generate inspiration. Students will develop a deeper interest in India's Glorious Past – by appreciating the need to read about it, research it, write about it, and share it.	2
9	**Learning from Legends-** A.P.J. Abdul Kalam	Dr Kalam's inspirational life displayed legendary qualities which apply to students (1) Dare to Dream (2) Work Hard (3) Get Good Guidance (4) Humility (5) Use Your Talents for the Benefit of Others	2
10	**Soft Skills-** Networking & Leadership	Students are taught the means of building a professional network and developing a leadership attitude.	2
11	**Soft Skills-** Project Management	Students will learn the secrets of project management through the Akshardham case study. They will then practice these skills through an activity relevant to student life.	2
12	**Remaking Yourself-** Handling Social Media	Students will learn how social media can become addictive and they will imbibe simple methods to take back control.	2
13	**Facing Failures-** Power of Faith	Students will learn about the power and necessity of faith in our daily lives.	2
14	**From House to Home-** Bonding the Family	Students will understand the importance of strong family relationships. They will learn how to overcome the generation gap and connect with their family more.	2
15	**Selfless Service-** Seva	Students will learn that performing seva is beneficial to one's health, wellbeing, and happiness. It also benefits and inspires others.	2

- **COURSE MATERIAL / MAIN COURSE WORKBOOK -**

1. IPDC Workbook-1 *(presented by B.A.P.S. Swaminarayan Sanstha)*

IPDC REFERENCES –

These are the reference material for the IPDC lectures. This is not compulsory reading for the

students as the essential information is contained in the workbooks.

Module No.	Module	References
1	Facing Failures	1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914 2. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 2017 **3. J.K. Rowling Harvard Commencement Speech | Harvard University Commencement, 2008** 4. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 2014 5. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007 6. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015 7. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007
2	Learning from Legends	1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life-Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013
3	My India My Pride	1. Rishis, Mystics, and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpith, 2011

		2. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 3. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982 4. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark,
		University of Chicago Press, reprint, Kessinger Publishing, 2006
4	Remaking Yourself	1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017
5	From House to Home	1. "What Makes a Good Life? Lessons from the Longest Study on Happiness", R. Waldinger, Ted Talks, 2015 **2. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 1995** 3. Outliers, Malcolm Gladwell, Back Bay Books, 2011
6	Soft Skills	1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 2013 2. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 2015 3. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Dan Ariely, Harper Perennial, 2010

7	Selfless Service	1. Open: An Autobiography, Andre Agassi, Vintage, 10 August 2010 2. The Physiological Power of Altruism [online], James Hamblin, The Atlantic, December 30, 2015, https://www.theatlantic.com/health/archive/2015/12/altruism-for-a-better-body/422280/ [last accessed June 10, 2020] 3. TBI Blogs: From Entrepreneurs to Doorkeepers, Everybody Serves with Love & Warmth at This Ahmedabad Café [online], The People Place Project, The Better India, May 29, 2017, https://www.thebetterindia.com/102551/small-way-serve-ahmedabad-seva-cafe/, [last accessed June 10, 2020]

Course Outcomes

- To provide students with a holistic value-based education that will enable them to be successful in their academic, professional, and social lives.
- To give the students the tools to develop effective habits, promote personal growth, and improve their wellbeing, stability, and productivity.
- To allow students to establish a stronger connection with their family through critical thinking and devolvement of qualities such as unity, forgiveness, empathy, and effective communication.
- To provide students with soft skills that complement their hard skills, making them more marketable when entering the workforce.
- To enhance awareness of India's glory and global values, and to create considerate citizens who strive for the betterment of their family, college, workforce, and nation.
- To inspire students to strive for a higher sense of character by learning from role models who have lived principled, disciplined, and value-based lives.

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Identify one habit to be transformed and ask student to execute it for 21 days	Activity duration =21 day. Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
2	Track social media usage: Decide one	Activity duration =15	Based on report

	social media app to be uninstalled from your phone for 15 days.	day. Duration= 5 hours	/Chart/Poster/Presentation submitted
3	To do seva activities at old age home, orphanage home, ,hospital, Cleanliness at school,society,college	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
4	Prepare a chart of famous failures.	Duration = 5 hours	Based on report /Chart/Poster/Presentation submitted
5	Make a team of 2-3 members .Plan the overall activities to be carried out for tech fest at your college, Make detailed list of activities to be done and budget plan.	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
6	Introspect and identify at least five scenario where you feel that your actions could be updated based on learning from listening and understanding	Duration =5 hours	Based on report /Chart/Poster/Presentation submitted
7	Sit with your family for 15 minutes a day discuss and share each other's activities(for Total 20 days)	Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
8	A well-organized plan for managing a **college tech fest** with a **team of 2–3 members**, including a **detailed list of activities** and a **budget plan**.	Duration =5 hour	Based on report submitted.
9	Sitting with your family for just **15 minutes a day** share each other's activities	Activity time = 5 hours (20 days) Report time = 5 hours	Based on report /Chart/Poster/Presentation submitted.
10	Group discussion: *What do I owe to my parents?* Write a Gratitude Letter to a parent/sibling/friend.	Duration= 1 hour	Based on report /Chart/Poster/Presentation submitted.
11	Prepare a "Personal Vision Statement" or "My Code of Living" booklet	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted.
12	Role-play or skit on miscommunication in relationships and solutions	Duration = 1 hour	Based on report /Chart/Poster/Presentation submitted
13	Community Seva (Service Activity): cleaning, helping elderly, teaching kids, etc. + reflection	Duration= 5 hours	Based on report /Chart/Poster/Presentation submitted
14	Self-Observation Diary: Record thoughts/emotions/actions for 10 days.	Duration = 1 hour	Based on report /Chart/Poster/Presentation submitted
15	Life Vision Journal: Write your 5-	Duration =1 hour	Based on report

	year vision—career, health, relationships, contribution. "My Life Compass" Poster: Personal motto, core values, role models, goals.		/Chart/Poster/Presentation submitted
16	Avoid all social media for 24 hours. Reflect: *What did I miss? What did I gain?*	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
17	Review and clean your social media: Unfollow toxic or negative accounts. Follow value-based, positive pages. Reflect: *What did I miss? What did I gain?*	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
18	Maintain a log of daily screen/social media usage for 3–5 days. Categorize it into productive vs unproductive time.	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted
19	Organize a physical or virtual tour to a local museum, heritage site, or historical monument.	Duration = 5 hour	Based on report /Chart/Poster/Presentation submitted
20	Students create weekly factsheets or digital posts sharing unknown facts from India's past (science, ethics, literature, and education).	Duration = 5 hour	Based on report /Chart/Poster/Presentation submitted
21	Watch a documentary (e.g., *Bharat Ek Khoj*, *Science in Ancient India*) and write a reflection on what surprised or inspired them.	Duration =1 hour	Based on report /Chart/Poster/Presentation submitted

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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w. e. f. Academic Year:	2024-25
Semester:	Ist Year
Category of the Course:	ESC

Pre-requisite:	NA
Rationale:	The Digital Fabrication Workshop equips students with essential hands-on skills required in the Electrical/Electronics and Computer hardware industries. With practical applications, students gain a comprehensive understanding of the Electrical hazards and electronics fabrication process. The course fosters to prepare students for more advanced studies and professional roles in engineering and technology.

Course Outcomes:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
01	Identify various electrical and electronic components, their symbols, and their functions	Remembering
02	Explain the operation and application of laboratory equipment and household wiring systems.	Understanding
03	Demonstrate proper soldering techniques and assembly of simple electronic circuits based on schematics.	Apply
04	Apply safety protocols and troubleshooting methods for electrical circuits and computer hardware.	Apply
05	Demonstrate computer system assembling and installation of Application software and System software	Apply

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
00	00	30	00	30	01	00	00	20	00	80	100

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

* **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Electrical and Electronics Components:** • Symbols: Understand the symbols used to represent various electrical and electronic components. • Types of Components: Explore resistors, inductors, capacitors, diodes, zener diodes, LEDs, photo diodes, transistors, and integrated circuits.	04	13
2.	**Laboratory Equipments:** • DC Power Supply, Function Generator, Multi-meter, LCR Meter, Wattmeter, Energy Meter, Clamp-On Meter, Digital Storage Oscilloscope (DSO). • Household Equipment and Wiring: Types of switches, types of cables, Tube light wiring, fan and fan regulator wiring, staircase wiring, godown wiring, panel layout and wiring, single line diagrams	04	14
3.	**Soldering Techniques:** • Types of Soldering (Through-Hole, Surface Mount) • Soldering Tools and Materials • Techniques for Soldering Electronic Components • Common Problems: Address issues like cold joints	04	14
4.	**Electronic Circuit Assembly and Testing:** • Reading and Understanding Circuit Schematics • Assembly of Simple Electronic Circuits • Testing and Troubleshooting Assembled Circuits	04	13

5.	**Safety and Protection:** • Electric shock, risks and precautions, safety, precaution during handling electric devices, first aid treatment for electric shock, Demonstration of CPR • Handling Electric Devices: Safety measures during handling • Earthing: Importance and methods • Fuses, MCB, ELCB: Protective devices	06	20
6.	**Computer Hardware Assembly:** • Components of a Computer System (CPU, RAM, HDD, Motherboard, etc.) • Assembling a computer: Step-by-Step Process Troubleshooting Common Hardware Issues • Understanding of Application Software and System Software and its installations.	04	13
7.	**Awareness/Demonstration On:** • Understand the basics of 3D printing technology, Types of 3D printers and Materials, Application of 3D printing in various Industries • Get Introduced Internet of Things (IoT) Concepts, Common IoT applications • Overview of Drone technology and Types of drones and their applications	04	13
	Total	**30**	**100**

Suggested Specification Table with marks (Practical):

Distribution of RBT level (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	20	60	00	00	00

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Make: Electronics by Charles Platt

2. The Beginner's Guide to 3D Printing by Samuel N. Bernier
3. Upgrading and Repairing PCs by Scott Mueller
4. Mr. S.Samaddar, Textbook of Electric Wiring, New Central Book Agency (P) Ltd., Calcutta.
5. Surjit Singh, Textbook of Electrical Design Estimating and Costing, Dhanpat Rai & Sons
6. Sengupta R., Textbook of Principles and Reliable Soldering Techniques, New Age International Ltd.
7. K. B. Bhatia, Textbook of Fundamentals of Maintenance of Electrical Equipments, Khanna Publishers.
8. Dr. S. K. Bhattacharya, Dr. S.Chatterji, Textbook of Projects in Electrical, Electronics,
9. Instrumentation and Computer Engineering, S. Chand Publishers., New Delhi.
10. National Electrical Code: Bureau of Indian Standards, Govt. Of India, 2011.
11. Operating Manuals of Various types of equipment

Suggested List of Practical/Experiments:

1. To study the symbols of various electrical and electronic equipment.
2. To understand the use of various laboratory equipments like DC power supply, Function Generator, Digital Storage Oscilloscope (DSO), Multi-meter, and Wattmeter.
3. To know about the different types of switches, indicators, and cables used in domestic wiring and panel wiring.
4. To design and verify the staircase wiring.
5. To design and verify the godown wiring.
6. To identify the components and pins of various electronic components like resistors, capacitors, diodes, LEDs, Transistors, etc.
7. Solder and de-solder electronic components on general-purpose board.
8. To demonstrate CPR as a first aid treatment for electric shock
9. To study the various protecting devices
10. To assemble-disassemble the computer system
11. To create a sample 3D model.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03000021
Subject Name : Digital Electronics

WEF Academic Year:	2024 - 2025
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite :	Not Applicable
Rationale :	Various number system, basic digital elements, combinational and sequential circuits and various logic families

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Understand different number system	RM/UN
02	Understand Boolean Algebra, Logic gates and its simplification	UN
03	Demonstrate combinational and sequential circuits	AP
04	Analyze combinational and sequential logic circuits	AN
05	Validate different logic family terminologies	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme :

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**BINARY SYSTEM:** Digital computer and digital systems, Binary Number, Number base conversions, Octal and Hexadecimal Number, Complements, Binary Codes, Binary Storage and register, Binary Logic, Integrated Circuit	3	6

2	**BOOLEAN ALGEBRA AND LOGIC GATES:** Basic Definitions, Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Minterms And Maxterms, Logic Operations, Digital Logic Gates	6	14
3	**SIMPLIFICATION OF BOOLEAN FUNCIONS:** The Map Method, 2, 3, 4, 5 and 6 variable maps, Product of sums simplification, NAND, NOR & other two level implementations, Don't Care Conditions, Tabulation Method and Determination and Selection of Prime-Implicants	6	14
4	**COMBINATIONAL LOGIC:** Introduction, Design Procedure, Adder, Subtractor, Code Conversion, Universal Gate and multilevel NAND and NOR circuits, Exclusive OR and Equivalence functions.	5	11
5	**COMBINATIONAL LOGIC WITH MSI AND LSI:** Introduction, Binary Parallel Adder, Decimal Adder, The look ahead carry Adder, Excess-3 Adder, Binary Multipliers, Parity bit Generators/checkers, Magnitude Comparator, Encoder, Decoder, Multiplexer, De-multiplexer.	5	11
6	**SEQUENTIAL LOGIC:** Introduction, Flip-Flops, Triggering of Flip-Flops, Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Flip-Flop Excitation Tables, Design Procedure, Design of Counters, Design with State Equations, The finite state model, Synthesis of synchronous sequential circuits, Serial Binary adder with Moore type FSM, The sequence Detector - Mealy type model and Moore type circuit.	5	11
7	**REGISTERS, COUNTERS AND THE MEMORY UNIT:** Introduction, Registers, Shift Registers, Ripple Counters, Synchronous Counters, Timing Sequences, Memory Unit – Role of memory in a computer system, memory types and terminology, Semiconductor RAM's, Non volatile RAM's, Magnetic Memories, Optical Disk Memory and Charged Coupled Devices.	5	11
8	**REGISTERS TRANSFER LOGIC & MICRO OPERATION:** Introduction, Inter-register Transfer, Arithmetic, logic and shift Micro-Operations, Conditional Control Statements, Fixed-Point Binary Data, overflow, Arithmetic Shifts, Decimal Data, Non – numeric Data, Floating-Point Data, Instruction Codes, Design of Simple Computer.	5	11

9	**DIGITAL INTEGRATED CIRCUITS:** Characteristics: Threshold voltage, Propagation Delay, Power dissipation, Fan-in, Fan-out, Voltage and current parameters, Noise margin, Operating Temperature, Speed power product. Transistor Transistor Logic: Two input TTL NAND gate, Totem pole output, Current sinking, Current sourcing, TTL loading and Fan-out. Open Collector gates: Wired AND operation, Tri state TTL, Buffer/Drivers.	5	11
	Total	**45**	**100**

Reference Book:

1. M. Morris Mano, "Digital Logic and Computer Design", Person India, LPE, 2017
2. A. Anand Kumar, "Fundamentals of Digital circuits", PHI, 4th Edition, 2016
1. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
2. Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education
3. Hanes et al "IoT Fundamentals", Cisco Press
4. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", , Paperback, 2015.
5. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
6. YashwantKanetkar, "21 Internet of Things Experiments", Kindle edition
7. AdeelJaved, "Building Arduino projects for Internet of Things", Apress publication
8. Donald Noris, "The Internet of Things: Do it yourself Projects with Arduino, Raspberry PI and
9. BeagleBone Black" Mc Graw Hill Publication
10. Adrian McEwen & Hakim Cassimally, "Designing the Internet of things", Willey publication
11. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
12. Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education
13. Hanes et al "IoT Fundamentals", Cisco Press
14. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", , Paperback, 2015.
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20. Adrian McEwen & Hakim Cassimally, "Designing the Internet of things", Willey publication
21. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication

Suggested Course Practical List:

1. To verify and interpret the logic and truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates.
2. To Realization of logic functions with the help of universal gates NAND and NOR Gate
3. To Verify De-Morgan's laws
4. To analyze the truth table of binary to gray and gray to binary converter
5. To design and verify operation of Half adder and Full adder.
6. To design and verify operation of Half Subtractor and Full Subtractor.
7. To design and verify operation of 4-bit full adder using IC 7483.
8. To design and verify operation of Encoder.
9. To design and verify operation of Decoder.
10. To design and implementation of 2-Bit Magnitude Comparator using logic gates and 4-Bit Magnitude Comparator using IC 7485.
11. Implementation of 4 X 1 Multiplexer using Logic gates and study of IC74151.
12. Implementation of 1X 4 Demultiplexer using Logic gates and study of IC 74154.
13. To verify the truth table of RS, JK, T and D flip-flops by using NAND & NOR gates ICs.
14. To analyze the circuit and truth table of 4-bit Bidirectional Universal shift register by using IC 74194.
15. To design and implement Asynchronous and synchronous Counters.
16. To design and verify the BCD counter using IC7490.
17. To simulate Logic circuits using Multisim simulator

List of Laboratory/Learning Resources Required:

1. Common Lab Manual (DTE)
2. Virtual Laboratory (vLab.co.in)
3. NPTEL Website

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB,	5 small coding-based assignment of 2h each.	Based on the coding solution submitted.

	MATLAB, MS-EXCEL or any other relevant software	Total = 10h	
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

- All the suggested activity should be related to the subject.
- Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03000031
Subject Name : Measurement and Instruments

WEF Academic Year:	2024 - 2025
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite :	Basics of Electrical Engineering and basics of Physics
Rationale :	To prepare students for experiments and design with various electrical, electronic measurements and instrumentation systems.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Understand basics of measurement	RM/UN
02	Understand working of various AC/DC meters, digital meters and Oscilloscope	UN
03	Demonstrate measurement of various parameters	AP
04	Analyze signal sources, interference signals and their elimination	AN
05	Evaluate various standards of data transmission in digital instrumentation systems	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme :

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction:** Methods and types of measurement, Classification of Instrument System, Types of Instruments and elements of Instruments and Measurement Systems ***Experimental Data and Errors:*** Measurement Recording and Reporting, Graphical Presentation of Data, Precision and Accuracy, Resolution and Sensitivity, Errors in Measurement, Statistical Evaluation of Measurement Data and Errors	**4**	**8**
2	**Analog DC and AC meters:** Electromechanically meter movements, PMMC, Analog DC ammeters, Analog DC voltmeters, Analog AC ammeters and Voltmeters, Analog multimeters, Special purpose analog meters, Use of basic meters, meter errors.	**5**	**11**
3	**Digital Meters:** DVM and Digital multimeter, 7 Segment LED and LCD display.	**3**	**6**
4	**Oscilloscope:** Oscilloscope subsystem, Principle of Operation, Display Subsystems, Vertical Deflection Subsystem, Dual Trace Feature, Horizontal Deflection Subsystem, Oscilloscope Probes, Oscilloscope Controls, How to operate an Oscilloscope – Measurement of Voltage, Current and Time, frequency, phase, Lissajous figures and different measurement using it, errors; oscilloscope photography, Digital storage oscilloscopes (DSO).	**6**	**13**
5	**Time & Frequency Measurement:** Time Measurements, Frequency measurement, Harmonic Analysis and spectrum analyzers.	**2**	**5**
6	**Power & Energy Measurement:** Power in AC-DC circuits, single-phase power measurements, Poly-phase power and measurements, Measurement of Power factor, Electrical energy measurements, Power measurements at higher frequencies.	**3**	**6**

7	**Measurement of Parameters :** ***Resistance:*** Resistance and resistor, resistor type, measurement of resistance, Wheatstone Bridge, Ammeter-voltmeter method, substitution method, Carey Foster Slide Wire bridge, Kelvin Varley Slide, Kelvin Double Bridge method, difficulties in measurement of high resistances, use of guard circuit, methods for measurement of high resistance, direct deflection ;method, Loss of charge method, megohm bridge method, measurement of insulation resistance with power on. ***Inductance:*** Inductors and inductance, Maxwell bridge, Hays Bridge, Anderson Bridge, Owen's Bridge, Heaviside Mutual Inductance Bridge, Carrey Foster ridge, Campbell's Bridge ***Capacitance:*** Capacitance and capacitors, capacitor circuit models and losses, capacitor types, color coding of capacitor, DeSauty's Bridge, chering Bridge ***Frequency:*** Wien's Bridge and its sources of errors ***Impedance:*** Impedance and Complex Impedance Measurements	**15**	**35**
8	**Transformers:** Current Transformer, Voltage Transformer, Testing and Applications	**2**	**5**
9	**Signal Sources, Interference Signals and their Elimination or Reduction:** Sweep Frequency generators, Pulse generators, Function generators, Oscillators, Capacitance interference, inductive interference and shielding, electromagnetic interference and shielding, conductive coupling interference, input guarding to reduce ground loop interference, internal noise.	**3**	**6**
10	**Data transmission in Digital Instrument System:** RS 232C Standard, 20mA Current Loop	**2**	**5**
	Total	**45**	**100**

Reference Book:

1. Wolf & Smith, "Student reference manual for Electronic and Instrumentation measurement", PHI Publication.
2. A. K. Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpatrai Publication.

A.K.Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpatrai Publication. [1] Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication

1. Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education
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17. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication

Suggested Course Practical List:

1. Introduction to Lab Equipment: Experimental data and Errors
2. Measurement of current and voltage using Analog meter
3. Extension of range of voltmeter
4. Extension of range of ammeter
5. Measurement of Resistance using Wheatstone Bridge
6. Low Resistance measurement using Kelvin Bridge
7. Self-Inductance Measurement using Maxwell Bridge
8. Measurement of Capacitance using De-Sauty Bridge
9. Measurement of Self Inductance of High-Quality Factor Coil by Hay's Bridge
10. Measurement of Capacitance by Schering Bridge
11. Introduction to Oscilloscope
12. Measurement of Frequency and Phase using Lissajous Pattern
13. Calibration of Single-phase Energy meter

14. Application of Wheatstone bridge for sensor signal conditioning
15. Mini project

List of Laboratory/Learning Resources Required:

1. Common Lab Manual (DTE)
2. Virtual Laboratory (vLab.co.in)
3. NPTEL Website

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills

10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
3. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
4. All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
5. Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03000041
Subject Name : Network Analysis

WEF Academic Year:	2024 - 2025
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite :	Fundamental knowledge of electric circuit sources and elements, basic mathematics (integration, differentiation, etc.)
Rationale :	Students of IC Engineering need to possess good understanding of concepts and principles of passive circuit analysis and synthesis by applying various circuit laws and theorems. This is one of the foundation courses which are required to understand the concepts of advanced courses and develop skills that are needed in Electronics field.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Apply dot convention & node convention analysis to various circuits.	RM/UN
02	To apply node and mesh circuit analysis techniques and various network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, Millman's Theorem, etc.	UN
03	Calculate Laplace Transform on one port and two port network.	AP
04	To apply graph theorem to solving networks.	AP

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme :

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
60	0	30	30	120	04	70	30	20	30	50	200

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Coupled Circuit and Dot Conventions:** Magnetically Coupled Circuit, Faraday's law of Electromagnetic induction, Self-induced emf and self-inductance, Mutually induced emf and Mutual induction, Coefficient of coupling, Dot Convention, inductive coupling of series-parallel, Conductively coupled equivalent circuit.	4	7
2	**Nodal Analysis and Mesh Analysis of resistive Circuits:** Nodal Analysis of Circuits Containing Resistors and Independent and Dependent Sources – Source Transformation Theorem for circuits with independent sources – Source Transformation Theorem for circuits with Dependent sources –Nodal Analysis of Circuits Containing Dependent Sources - Mesh Analysis of Circuits with Resistors and Independent Voltage Sources- Mesh Analysis of Circuits with Independent Sources - Mesh Analysis of Circuits Containing Dependent Sources.	7	11
3	**Circuit Theorems and Their Application in Electric Networks:** Linearity of a Circuit and Superposition Theorem-Substitution Theorem-Compensation Theorem - Thevenin's Theorem and Norton's Theorem -Determination of Equivalents for Circuits with Dependent Sources -Reciprocity Theorem - Maximum Power Transfer Theorem - Millman's Theorem-Duality Theorem - Duality between Electricity and Magnetism.	9	18
4	**Time domain response of First order RL and RC circuits:** Mathematical preliminaries – Source free response –DC response of first order circuits – Superposition and linearity – Response Classifications	4	7
5	**Time domain response of Second order linear circuits:** Discharging of a Capacitor through an inductor – Source free second order linear networks – second order linear networks with constant inputs.	5	7
6	**Initial Conditions:** Initial conditions in elements, procedure for evaluating initial conditions, Solution of circuit equations by using Initial Conditions.	4	7

7	**Laplace Transform Analysis and its Applications:** Notions of Impedance and Admittance – Manipulation of Impedance and Admittance- Notions of Transfer Function- Equivalent circuits for inductors and capacitors – Nodal and Loop analysis in the s-domain – Switching in RLC circuits- Switched capacitor circuits and conservation of charge	**8**	**10**
8	**Two –Port Networks :** One port networks –Driving Port and Transfer function for one port and two port network, Poles and zeroes of network functions, Two port admittance Parameters (y parameters)– Admittance parameters analysis of terminated two- Port networks - Two port impedance Parameters (z-parameters) –Impedance and Gain calculations of terminated two- Port networks modeled by z-parameters – Hybrid parameters (h para)– Inverse Hybrid Parameters (g-para)- Transmission parameters (ABCD parameters)-Scattering parameters(S parameters)-Scattering Transfer parameters(T parameters) –reciprocity-Various Combinations of Two-Port network-Various Combinations of Two port n/w.	**9**	**15**
9	**Introduction to Network Topology:** Linear Oriented Graphs (Connected Graph, Sub graphs and Some Special Sub graphs) - The Incidence Matrix of a Linear Oriented Graph -Kirchhoff's Laws in Incidence Matrix Formulation - Nodal Analysis of Networks – The Circuit Matrix of a Linear Oriented Graph- Kirchhoff's Laws in Fundamental Circuit Matrix Formulation - Loop Analysis of Electrical Networks – (Loop Analysis of Networks Containing Ideal Dependent Sources- Planar Graphs and Mesh Analysis –Duality)- The Cut-set Matrix of a Linear Oriented Graph (Cut-sets - The All cut-set matrix Qa- Orthogonality relation between Cut-set matrix and Circuit matrix - The Fundamental Cut-set Matrix Qf - Relation between Qf , A and Bf) - Kirchhoff's Laws in Fundamental Cut-set formulation - Tie set -Tie set Matrix (F-loop matrix)- Tie set schedule.	**10**	**18**
	Total	**60**	**100**

Reference Book:

1. Network Analysis & Synthesis By Franklin S. KUO, Wiley Publication
2. Network Analysis :- By M.E Van Valkenburg PHI Publication
3. Electric Circuits and Networks :- By K. S. Suresh Kumar – Pearson Education
4. Linear Circuits Analysis 2nd edition :-By DeCarlo/ Lin – Oxford University Press(Indian edition)

5. Engineering Circuit Analysis : - By W H Hayt, J E Kemmerly, S M Durbin 6th Edition TMH Publication
6. Graphs: Theory and Algorithms By K. Thulasiraman, M.N.S Swamy, Wiley Publication.
7. Electric Circuit Analysis By S N Sivanandam, Vikas Publishing House
8. Introductory Circuit Analysis by Robert Boylestad, Pearson.

A.K.Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpatrai Publication.

1. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
2. Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education Hanes et al "IoT Fundamentals", Cisco Press
3. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", , Paperback, 2015.
4. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
5. YashwantKanetkar, "21 Internet of Things Experiments", Kindle edition
6. AdeelJaved, "Building Arduino projects for Internet of Things", Apress publication
7. Donald Noris, "The Internet of Things: Do it yourself Projects with Arduino, Raspberry PI and BeagleBone Black" Mc Graw Hill Publication
8. Adrian McEwen & Hakim Cassimally, "Designing the Internet of things", Willey publication
9. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
10. Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education Hanes et al "IoT Fundamentals", Cisco Press
11. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", , Paperback, 2015.
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16. BeagleBone Black" Mc Graw Hill Publication
17. Adrian McEwen & Hakim Cassimally, "Designing the Internet of things", Willey publication
18. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication

- **Suggested Course Practical List:**

1. To measure and calculate currents and voltages for a given resistive circuit and verify KCL and KVL.
2. To verify superposition theorem experimentally for a given resistive circuit consisting two independent sources.

3. To verify Thevenin's theorem experimentally for a given circuit.
4. To verify maximum power transfer theorem experimentally for a given circuit.
5. To verify reciprocity theorem experimentally for a given circuit.
6. To measure and calculate RC time constant for a given RC circuit.
7. To measure and calculate RC time constant for a given RL circuit.
8. To measure and analyze (settling time, overshoot, undershoot, etc.) step response of for a given series RLC circuit for following cases: (1) $\zeta = 1$ (critically damped system), (2) $\zeta > 1$(over damped system), (3) $\zeta < 1$ (under damped system). Choose appropriate values of R, L, and C to obtain each of above cases one at a time.
9. To measure and calculate Z-parameters for a given two-port system.
10. To measure and calculate Y-parameters for a given two-port system.
11. To measure and calculate h-parameters for a given two-port system.
12. To measure and calculate ABCD-parameters for a given two-port system.

List of Laboratory/Learning Resources Required:

1. Common Lab Manual (DTE)
2. Virtual Laboratory (vLab.co.in)
3. NPTEL Website

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and	Based on the depth of the solution submitted.

		solution finding, Total = 10h	
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

- All the suggested activity should be related to the subject.
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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code : BE03000051

Subject Name : Professional Communication and Ethics

w. e. f. Academic Year:	2024 - 2025
Semester:	3
Category of the Course:	HSMC

Prerequisite:	Students must have knowledge of basic English
Rationale:	The rationale of the curriculum is to equip students with the knowledge, skills and ethical frameworks necessary for academic and professional success. The curriculum fosters effective communication, critical thinking and responsible decision-making in diverse real-world contexts.

Course Outcome:

After completion of the course, students will be able to:

No	Course Outcomes	RBT Level
01	Understand and apply the fundamentals of professional communication and relate it to real life situations	R,U,A,N,E
02	Compose essential formal documents in appropriate formats for various professional situations	R,U,A,C
03	Demonstrate advanced communication skills in presentation, public speaking, and contribute effectively in group communication	R,U,A,N,E,C
04	Practice professional manners and etiquette and imbibe people skills for professional communication	R,U,A,N,E,C
05	Understand professional ethics and ethical dilemmas to devise solutions	R,U

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL/ (I)	ESE (V)	
30	0	30	0	60	02	70	30	20	0	50	170

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Professional Communication:** • Fundamentals of Communication: Definition, concept and models (Linear Model, Shannon and Weaver Model) • Characteristics of Language • Levels of Communication: Intrapersonal, Interpersonal, Extra personal, Organizational, Mass, Cultural Communication • Flow of Communication • Barriers of Communication • Nonverbal Communication: Kinesics, Proxemics, Paralinguistic features, Chronemics, Haptics, Olfactics, Oculesics	5	20
2.	**Professional Documentation:** • Business Letter Writing (Inquiry, Reply, Order, Complaint, Adjustment, Sales, Requesting purchase on Credit, Accepting or Rejecting the Credit request) • Memo writing as an internal organizational Communication • Report Writing (Memo format, Letter format) • Preparing Agenda, Notice and Minutes of Formal Meeting • Email Writing • Professional Resume writing • Technical Proposal (Solicited / Unsolicited) • Technical Description Note*Only practical and application type questions shall be asked from this unit.	5	15

3.	**Advanced Public Speaking Skills:** **1. Presentation:** • Organizing Professional Presentations: Structuring the speech effectively, Outlining key points, Developing compelling introductions and conclusions • Delivery Techniques: Extemporaneous, Memorization, Impromptu, Manuscript • Using Presentation Aids: Integrating presentation aids into speeches, Designing effective presentation aids **2. Public Speaking:** • Mediated public speaking • Informative speaking • Persuasive speaking and methods of persuasion • Special occasion speaking • Motivational Speaking **3. Interview Skills:** • Objectives of interviews • Types of interviews (telephonic, face-to-face - campus and on-site) • Stages of job interviews **4. Group Discussions:** • Organizational Group Discussions (Nominal, Delphi, rainstorming) • Group discussions as part of the selection process **5. Group Communication:** • Meetings, Conferences, Symposia and Seminars	6	20
4.	**Professional Etiquette: Essential Guidelines (Requirements, Dos & Don'ts):** • Concept of Social Manners, Morals and Etiquette • Etiquette for Small Talks • Workplace Etiquette • Mobile Etiquette • Internet & Social Media Etiquette • Etiquette for Foreign Business Trip • Etiquette for the Visit of Foreign Counterpart	5	15
5.	**People Skills for Professional Communication:** • Time Management • Stress Management • Respecting Privacy • Learning to Say 'No'	5	15

	• Team Building • SWOT Analysis • Creative and Critical thinking • Physical Quotient, Intelligence Quotient, Emotional Quotient, Spiritual Quotient		
6.	**Professional Ethics** • Concept of Ethics • Importance of Ethics in Life • Principles of Ethics • Engineering Ethics • Understanding and Resolving Ethical Dilemmas • Corporate Social Responsibility (CSR)	4	15
	Total	**30**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25	25	20	10	10	10

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Ramesh and Ramesh, *The Ace of Soft Skills,*Pearson, 2019
2. Raman M. and Sharma S., *Technical Communication: Principles and Practice,* OUP, New Delhi, 2017
3. Lata P. and Kumar S., *Communication Skills,* OUP, New Delhi, 2018
4. Dan O' Hair, Rubenstein Hannah and Stewart Robert, *A Pocket guide to Public Speaking,*5th Edition, Bedford/st.Martins,2015
5. Mitra B., *Personality Development and Soft Skills,*1st Edition, OUP, 2011,
6. Fraleigh D. and Joseph T.*Speak Up!: An Illustrated Guide to Public Speaking,*5th Edition, Bedford/st.Martins,2019
7. Pillai S. and Fernandez A., *Soft Skills and Employability Skills,* Cambridge University Press, 2017
8. Shinde, *Life Skills and Personality Development,* Cambridge University Press, 2022
9. Alex K., *Soft Skills – Know Yourself and Know the World,* 3rdEdition, S. Chand, 2014
10. Seebauer Edmund G. and Barry Robert L., *Fundamentals of Ethics for Scientists and Engineers,* Oxford University Press, 2008

11. Harkut Dinesh G. and Bamnote Gajendra R., *Professional Ethics for Engineers*, Notion Press, 2023

(b) Open source software and website:

1. https://www.scu.edu/ethics/focus-areas/more-focus-areas/engineering-ethics/engineering-ethics-cases/

Suggested Course Practical List/ List of Laboratory Activities:

Sr. No.	List of Practical	No. of Hours	Preferably to be conducted in
1	Communication game by passing message to understand the barriers	2	Classroom/Lab
2	Letter Writing	4	Classroom/Lab
3	Preparing Professional Resume	2	Classroom/Lab
4	Notice, Agenda and Minutes of Meeting	2	Classroom/Lab
5	Email writing	2	Classroom/Lab
6	Report Writing	2	Classroom/Lab
7	Technical Proposals	2	Classroom/Lab
8	Case Studies on Ethical Dilemmas and Solving them	4	Classroom/Lab
9	Mock Interviews, GDs	4	Classroom/Lab
10	Book Review	2	Classroom/Lab
11	Preparing content for popular Digital Platforms (Advertisement, Digital Brochure, Digital Portfolio, Website, Academic Use of AI, Blog - Podcast - Vlog etc)	4	Classroom/Lab
12	Presentations(online and offline)	2	Classroom/Lab
	Total Hours:	32	

Suggested Books List for Book review:

1. You Can Win by Shiv Khera
2. How to win friends and influence people by Dale Carnegie
3. Getting things done: The art of stress free productivity by David Allen
4. Quiet: The Power of Introvert in the World they can't stop talking by Susan Cain
5. The Alchemist by Paulo Coelho
6. The 7 habits of highly effective people by Stephen Covey
7. What to say when you talk to yourself by Dr. Shad Helmstetter
8. The big leap by Gay Hendricks
9. Thinking fast and slow by Daniel Kahneman
10. The art of thinking clearly by Ralf Dobelli

11. Upside –Down King by Sudha Murthy
12. Born to be happy by Pramod Batra
13. Ikigai: The Japanese Secret to a Long and Happy Life By by Héctor García & Francesc Miralles
14. Poor little rich slum by Rashmi Bansal
15. Most and more by Mahatria Ra
16. The Old Man and the Sea by Ernest Hemingway
17. Rich Dad Poor Dad by Robert Kiyosaki
18. The Monk Who Sold His Ferrari by Robin Sharma
19. Who Moved My Cheese? By Dr. Spencer Johnson
20. The Business of the 21st Century by Robert Kiyosaki
21. My Experiments with Truth by Mahatma Gandhi
22. Five Point Someone by Chetan Bhagat
23. The Secret by Rhonda Byrne
24. The Power of Positive Thinking by Norman Vincent Peale
25. The Power of Your Subconscious Mind by Joseph Murphy
26. The 5 AM Club by Robin Sharma
27. Who will cry when you die? By Robin Sharma
28. Discover Your Destiny by Robin Sharma
29. The Wing of Fire by A.P.J. Abdul Kalam
30. I have a Dream by Rashmi Bansal
31. The 5 Steps to Success by Yandamoori Veerendranath
32. You Are Born To Blossom by A.P.J. Abdul Kalam
33. Tiya: A Parrot's Journey Home by Samarpan
34. The God of Small Things by Arundhati Roy
35. How to develop a 'Never Give up' Attitude by Dr. Hardik Joshi
36. Three Thousand Stitches: Ordinary People, Extraordinary Lives by Sudha Murthy
37. Chanakya in Daily Life by Radha Krishnan Pillai
38. Siddhartha by Hermann Hesse
39. Kiss that Frog by Brian Tracy
40. Eat That Frog!: 21 Great Ways to Stop Procrastinating and Get More Done in Less Time by Brian Tracy

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w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Core Courses

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Enhance human values , create awareness about law enactment and importance of Constitution	10%
CO-2	To Understand the Fundamental Rights and Fundamental Duties of The Indian Citizen to instill morality, social values, honesty, dignity of life and their social Responsibilities.	30%
CO-3	Create Awareness of their Surroundings, Society, Social problems and their suitable solutions while keeping rights and duties of the Citizen keeping in mind.	20%
CO-4	Understand distribution of powers and functions of Local Self Government.	20%
CO-5	Understand the National Emergency, Financial Emergency and their Impact on Economy of the country.	20%

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
30	00	00	30	60	02	50	00	00	30	00	80

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

Contents:

Sr. No.	Topics	Total Hours
1	Meaning of the constitution law and constitutionalism	01
2	History of Indian Constitution	02
3	Salient features and characteristics of the Constitution of India	01
4	Fundamental rights	02
5	Right to Equality under Article – 14	02

6	Right to certain Freedom under Article 19	02
7	Scope of the Right to Life and Personal Liberty under Article 21	02
8	Fundamental Duties and its legal status	02
9	The Directive Principles of State Policy – Its importance and implementation	02
10	Federal structure and distribution of legislative and financial powers between the Union and the States	03
11	Parliamentary Form of Government in India – The constitution powers and status of the President of India	02
12	Powers and Procedure for Amendments in Indian Constitution	01
13	History of amendments in Indian Constitutional	02
14	Emergency Provisions : National Emergency, President Rule, Financial Emergency	03
15	Local Self Government – Constitutional Scheme in India	03

Reference Books:

1. Constitutional Law of India, Dr. J.N. Pandey, Central Law Agency
2. Introduction to the Consitution of India, Durga Das Basu, LexisNexis.
3. Indian Constitutional Law, M.P. Jain, LexisNexis
4. V.N.Shukla's Constitution of India, Mahndra Pal Singh, Eastern Book Company
5. Constitutional Law – I Structure, Udai Raj Rai, Eastern Book Company

* List of suggested activities for Problem Based Learning:

Each topic includes an exploratory and a reflective/creative activity, mapped to course outcomes.

Topic No.	Topic Title	Activity Details	Video Link / Reading Material Link	Estimated Time	Mapped COs
1	Meaning of Constitution, Law & Constitutionalism	1. Watch: Intro to Constitution – NPTEL After watching, list 5 key differences between Constitution, law, and constitutionalism in your own words. 2. Create a **concept map** showing relationships between Constitution, laws, and constitutionalism.	Intro to Constitution – NPTEL	2 hours	CO-1
2	History of Indian Constitution	1. Watch: https://www.youtube.com/watch?v=0U9KDQnIsNk 2. After watching, note 5 key	https://www.youtube.com/watch?v=0U9KDQnIsNk	2 hours	CO-1

		events that shaped India's Constitution and explain their significance. 3. 2. Create a **timeline chart** from 1857 to 1950 showing key constitutional developments.			
3	Salient Features of the Constitution	1. Watch: Salient Features – SBR ✎ After watching, list at least 8 salient features and mention their relevance today. 2. Prepare a **comparison table** between India's Constitution and UK/US Constitution on at least 5 points.	Salient Features – SBR ✎	2 hours	CO-1
4	Fundamental Rights	1. Watch: https://www.youtube.com/watch?v=cAjq_8JcUNw 2. After watching, write 1 paragraph summarizing the purpose of Fundamental Rights. 3. 2. Create a **flipbook or digital slides** explaining each Fundamental Right with real-life examples.	https://www.youtube.com/watch?v=cAjq_8JcUNw	2 hours	CO-2
5	Right to Equality (Art. 14)	**1 Public Policy in Action: Anti-Discrimination Notices Activity** To identify and analyze visible government or institutional efforts to promote equality and prevent discrimination in public spaces, and to connect these initiatives to the constitutional principle of equality under Article 14.	https://indiankanoon.org/doc/367586/ Article 14 in Constitution of India	2 hours	CO-2

		Task: 1. **Choose a Public Place:** Visit a public place such as a government office (e.g., Post Office, Municipal Corporation), a hospital, a transport hub (bus stand, railway station), a bank, a college, or a market area. 2. **Search for Notices/Posters:** Actively look for any official notices, posters, signboards, or information displays that reflect government policies or legal provisions aimed at preventing discrimination, promoting equality, or ensuring inclusive access. **Think broadly:** Look for signs related to: ✓ Prohibition of discrimination (e.g., against caste, gender, religion). ✓ Accessibility for persons with disabilities (e.g., ramps, special counters, accessible toilets). ✓ Equal opportunity statements. ✓ Anti-harassment policies (e.g., sexual harassment at workplace). ✓ Rights of specific vulnerable groups (e.g., women, children, senior citizens, transgender persons). ✓ Information about helplines or grievance redressal mechanisms for discrimination.			

		3. **Document Your Finding:** ➢ If possible, take a clear photo of the notice/poster (ensure no people are identifiable in the background for privacy). ➢ Note down the exact text or key message of the notice. ➢ Note where you found it (e.g., "On the notice board near the reception in X Hospital," "Near the accessible ramp at Y Bus Stand"). 4. Write a short reflection in **100-150 words** **2. Creative Poster** Design a poster or digital collage with the theme: **"Equality Before Law – Everyone Counts."** Include visuals, quotes, or examples that promote fairness, accessibility, and inclusion.			
6	Freedom Rights (Art. 19)	1. Watch: https://www.youtube.com/watch?v=l2fN9pbpa_s After watching, list 3 limitations on freedom of speech explained in the video. 2. Write a **debate script or essay** discussing whether hate speech should be protected under freedom of speech.	https://www.youtube.com/watch?v=l2fN9pbpa_s	2 hours	CO-2
7	Right to Life & Personal Liberty (Art. 21)	1. Study: Puttaswamy case. 2. After reading, explain in 100 words how the case expanded the meaning of Art. 21. 3. 2. Create a **privacy & liberty chart** with 5 examples of rights protected under Article 21.	https://indiankanoon.org/doc/91938676/ (**Justice K.S.Puttaswamy (Retd) And Anr. vs Union Of India And Ors. on 24 August, 2017**)	2 hours	CO-2
8	Fundamental	1. Watch: Fundamental Duties		2 hours	CO-2

	Duties & Legal Status	Explained After watching, list at least 5 Fundamental Duties and explain their significance briefly. 2. Design a **poster or infographic** titled "My Duties as a Citizen".	Fundamental Duties Explained		
9	Directive Principles of State Policy (DPSP)	1. Study any one DPSP-related cases where courts directed policy change. 2. After reading, summarize in 150 words how DPSPs guided the court's decision. 3. Write a **blog-style policy note** on any one unfulfilled DPSP in India and how it can be implemented.	1. https://indiankanoon.org/doc/40715/ (Mohini Jain v. State of Karnataka (1992) 1. ps://indiankanoon.org/doc/1775396/ Jnni Krishnan v. State of Andhra Pradesh (1993)) 2. https://indiankanoon.org/doc/1939993/ (Minerva Mills Ltd. vs Union of India (1980)	2 hours	CO-2, CO-3
10	Federal Structure & Power Distribution	1. Watch: https://youtu.be/jN_IVXQr3DQ?si=7rTGTlwMY2HU0eED 2. After watching, list 3 major disputes between Centre & States discussed. 3. Create a **color-coded chart** comparing Union, State, and Concurrent Lists with examples.	https://youtu.be/jN_IVXQr3DQ?si=7rTGTlwMY2HU0eED	2 hours	CO-3
11	Parliamentary Government & President's Role	1. Watch: https://www.youtube.com/watch?v=t-uMxrplttM 2. After watching, explain in 5 bullet points how the President and PM interact in government. 3. 2. Prepare a **role-play script or PPT** depicting how decisions are made between President, PM, and Parliament.	https://www.youtube.com/watch?v=t-uMxrplttM	2hours	CO-3
12	Amendment	1. Watch:	https://www.youtube.c	2 hours	CO-3

	Process	https://www.youtube.com/watch?v=yVp5QZQzYH0 2. After watching, write a short summary explaining what "Basic Structure Doctrine" means. 3. 2. Create a **timeline infographic** showing 5 major constitutional amendments and their impacts.	om/watch?v=yVp5QZQzYH0		
13	History of Constitutional Amendments	1. Read about the evolution of constitutional amendments from 1951 onward. 2. After reading, summarize key trends and changes in one page. 3. Mock amendment proposal preparation. **Task:** Think of a **current national issue or gap** (e.g., climate rights, digital privacy, mental health in education). • Write one page mock **constitutional amendment proposal**: ○ Title of the amendment ○ Proposed text ○ Why it is needed ○ How it fits into the Constitution's values	https://lawblend.com/articles/constitutional-amendments-list/ Wikipedia: Constitutional Amendments of India (well-sourced)	2 hours	CO-3
14	Emergency Provisions	1. Watch: https://www.youtube.com/watch?v=vBmPFPIm7Fk 2. After watching, explain in 150 words why Emergency provisions are considered controversial. 3. 2. Write a **reflective essay** discussing the long-term impact of the Emergency on democracy.	https://www.youtube.com/watch?v=vBmPFPIm7Fk	2 hours	CO-5
15	Local Self Government	1. Interview/visit a local	https://www.youtube	2 hours	CO-4

		Panchayat/Corporator or watch a video on Panchayati Raj functioning. https://www.youtube.com/watch?v=V24GhpZ-Mpo After the activity, write 3 key observations about challenges faced by local self-governments. 2. Write a **field report** with improvement suggestions for the Panchayat or ULB system.	.com/watch?v=V24GhpZ-Mpo		

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03000241
Subject Name: Indian Knowledge System for Engineering

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Humanities and Social Science, including Management Courses (Elective)

Prerequisite:	The course remains accessible to all engineering disciplines, regardless of specific technical background.
Rationale:	To provide an in-depth understanding of the evolution of engineering practices in India, from ancient times to the modern period, highlighting key contributions, technological advancements, and the integration of engineering concepts with cultural, social, and economic contexts. The course also aims to connect historical developments with contemporary engineering challenges and future prospects.
Pedagogy	The course employs a blended pedagogical approach combining lectures, storytelling, case studies, and multimedia presentations to enhance student engagement and understanding. Historical engineering practices and developments are explored through archaeological evidence, textual references, and documentary resources. Interactive discussions will be encouraged to critically reflect on India's indigenous knowledge systems and their relevance in modern engineering contexts. Students will be guided to connect historical examples with contemporary engineering challenges and innovations. NPTEL resources, archival material, and visual documentaries will supplement classroom teaching, promoting contextual and interdisciplinary learning.

Course Outcomes:

Sr. No.	CO statement	Bloom's Taxonomy Level	Marks% weightage
CO-1	Describe the evolution of engineering practices in India from ancient to modern times.	UN	20
CO-2	Explain major engineering innovations and technological developments in various historical periods of India.	UN	20
CO-3	Analyze the influence of socio-political and economic factors on the development of engineering and infrastructure across dynasties and regimes.	AN	20
CO-4	Evaluate the role of engineering in India's industrialization, modernization, and nation-building efforts.	EL	20
CO-5	Assess contemporary engineering advancements and propose sustainable solutions for future challenges.	CR	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
30	00	30	00	60	2	70	30	20	00	50	170

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to the Indian History of Engineering** Overview and importance of the study of engineering history in India. Historical context of engineering practices across different periods of Indian civilization. Relationship between engineering, architecture, and technological innovations. Overview of India's contributions to global engineering knowledge. Methodologies for studying historical engineering practices (archaeological, literary, and architectural sources).	**3 hours**
2	**Ancient Engineering Innovations** **Indus Valley Civilization** Urban planning and architectural marvels (e.g., drainage systems, granaries, town layouts). Water management systems, wells, reservoirs, docks (e.g., Lothal). Metallurgy and craftsmanship (tools, pottery, bead-making, seals). **Vedic and Post-Vedic Periods** Early construction of temples, fortifications, fire altars. Developments in water harvesting and irrigation techniques. Application of geometry and mathematics in construction (Sulba Sutras). **Scientific and Engineering Thought in Ancient Texts** Arthashastra, Manusmriti: Engineering guidelines, civic planning, metallurgy. Principles of town planning, building design, resource management.	**3 hours**

3	**Classical and Early Medieval Engineering** **Engineering during the Gupta Period** Advances in construction techniques for temples, monuments (e.g., Dashavatara Temple). Rock-cut architecture, structural temples, use of iron pillars. **Medieval India – Sultanate and Early Mughal Period** Fort architecture (e.g., Golconda Fort), palatial structures. Hydraulic engineering: Stepwells (vavs), baolis, irrigation tanks. **Water Management and Agricultural Engineering** Techniques for sustainable agriculture and irrigation across different regions. Case studies: Chola irrigation systems, Delhi Sultanate canal systems.	**3 hours**
4	**Engineering and Technology in the Late Medieval and Mughal Periods** Monumental engineering projects (e.g., Taj Mahal, Fatehpur Sikri). Advances in construction materials (lime mortar, sandstone, marble). Urban planning in Mughal cities (e.g., Shahjahanabad). Water supply and drainage systems in Mughal forts and cities.	**3 hours**
5	**Early Colonial Period and Transformation of Indian Engineering** **British Influence on Indian Engineering** Introduction of Western surveying, mapping, civil engineering practices. Establishment of Thomason College of Civil Engineering (Roorkee). **Growth of Infrastructure under Colonial Rule** Railways, bridges, ports, telegraph networks. Canal building and irrigation projects (e.g., Ganges Canal). **Indian Engineers under British Rule** Contributions of Indian engineers (e.g., Sir M. Visvesvaraya). Challenges faced by indigenous engineers.	**3 hours**
6	**Rise of Modern Engineering Post-Independence** **Institution Building** Founding of IITs, NITs, engineering research centers. **Civil Engineering Achievements** Key projects: Bhakra Nangal Dam, Hirakud Dam, Sardar Sarovar Project. Development of national highways (Golden Quadrilateral). **Agricultural and Irrigation Engineering** Green Revolution technologies. Role of engineering in rural development and food security.	**3 hours**

7	**Industrialization and the Engineering Sector in India** **Early Industrialization** Steel plants (TISCO), textile mills, chemical plants. Machine tool development and mechanical engineering initiatives. **Public Sector Enterprises and Engineering Innovations** Establishment of Bharat Heavy Electricals Limited (BHEL), Hindustan Aeronautics Limited (HAL). **Technological Modernization of Industry** Automation, manufacturing advancements, materials engineering.	**3 hours**
8	**Modern Technological Advancements** **Space Technology** Formation and growth of ISRO. Major achievements: Aryabhata, SLV-3, PSLV, Chandrayaan, Mangalyaan. **Nuclear Engineering** Role of Bhabha Atomic Research Centre (BARC). Development of nuclear energy for power generation. **IT and Software Engineering** Growth of IT hubs (Bengaluru, Hyderabad). Impact of software exports and services. Role of Indian engineers in global tech innovation.	**3 hours**
9	**Emerging Frontiers and Sustainability in Indian Engineering** **Biotechnology and Biomedical Engineering** Advances in pharmaceutical research, genetic engineering, and medical devices. **Green Engineering and Sustainable Technologies** Renewable energy (solar, wind, hydropower initiatives). Engineering solutions for climate change mitigation. Environmental sustainability projects.	**3 hours**
10	**Challenges and the Future of Indian Engineering** **Contemporary Challenges** Infrastructure gaps, urbanization pressures, rural engineering needs. Challenges in engineering education and innovation ecosystem. **Future Trends** AI, robotics, IoT, smart city projects. India's role in global collaborations (e.g., QUAD tech initiatives, space cooperation). Policy frameworks: "Make in India", "Atmanirbhar Bharat", National Education Policy (NEP) 2020 initiatives.	**3 hours**
TOTAL		**30 Hours**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**20**	**10**	**10**	**20**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. *Engineering in India Through the Ages*, INSA, INSA New Delhi, 2004
2. *Science and Technology in Ancient India* by Debiprasad Chattopadhyaya, People's Publishing House, 2022
3. *India's Ancient Past* by R. S. Sharma, Oxford University Press, 2020
4. *History of Science, Philosophy and Culture in Indian Civilization* edited by D. P. Chattopadhyaya, Centre for Studies in Civilizations, 2000–2010
5. *From Temples to Dams: Engineering and Civilizations in India* by R. Balasubramaniam, Aryan Books International, 2021
6. *Sir M. Visvesvaraya: The Builder of Modern India* by N. K. Dikshit, National Book Trust, 2018
7. *India After Gandhi* by Ramachandra Guha, HarperCollins India, 2017

List of Experiments: NA

Major Equipment: NA

List of Open Source Software/learning website:

- **NPTEL Courses:**
  - History of Science and Technology in India (IIT Madras)
  - Science, Technology and Society
- **YouTube / Documentary Channels:**
  - *Pradhanmantri Series* (by ABP) – for post-1947 policy
  - *History Channel India* – for ancient technology features
- **Web Portals:**
  - INSA India – Publications on Indian Science History
  - Vigyan Prasar Digital Library – Rich source of science communication and heritage

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code : BE03000261

Subject Name : Signals and Systems

WEF Academic Year:	2024-25
Semester:	3
Category of the Course:	Basic Science Course

Prerequisite :	Basic knowledge of integration, differentiation and complex numbers.
Rationale :	This course will provide the students (i) understanding of the mathematical description of continuous and discrete time signals and systems, (ii) to classify signals into different categories, (iii) to analyze Linear Time Invariant (LTI) systems in time and transform domains, and (iv) to build foundation for understanding of courses such as control system and signal processing.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Classify various types of signals and systems, and perform various operations on them.	UN
02	Analyze CT and DT systems in time domain using convolution.	UN/AP
03	Use transforms for the analysis of signals and systems in continuous and discrete time domain	AP
04	Analyze DT systems using z-transforms.	AN

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Classification of Signals and Systems** Introduction to signals and systems: Continuous Time (CT) and Discrete Time (DT) signals, Periodic and Aperiodic signals, Even and Odd signals, Energy and Power signals, Deterministic and Random signals. Standard signals: Impulse, Step, Ramp, Pulse, Real and Complex exponential and Sinusoidal. Classification of systems: CT and DT, Memory and Memory less, Casual and Non-casual, Inverse, Stable and Unstable, Time-variant and Time-invariant, Linear and Nonlinear systems.	5	11
2	**Linear Time Invariant(LTI) systems** Discrete time LTI systems, Continuous time LTI systems, Properties of LTI systems.	5	15
3	**Fourier Series Representation of Periodic Signals** Introduction, A historical perspective, The response of LTI systems to complex exponentials, Fourier series representation of continuous time periodic signals and discrete time periodic signals, Properties of CT Fourier series and DT Fourier series, Fourier series and LTI systems, Filtering, Examples of CT filters described by differential equations.	9	21
4	**The Continuous Time Fourier Transform (CTFT)** Introduction, Representation of aperiodic signals – CTFT, Fourier transform for periodicsignals, Properties of CTFT, Convolution property.	7	15
5	**The Discrete Time Fourier Transform (DTFT)** Introduction, Representation of aperiodic signals, Fourier transform for periodic signals, Properties of DTFT, Convolution property.	7	15
6	**The Laplace Transform (Review)** Introduction, Definition, Region of convergence (ROC), Inverse Laplace transform, Properties of the Laplace transform, Analysis and characterization of LTI systems using the Laplace transform: Causality, Stability.	5	8

7	**The Z-Transform** Introduction, Definition, Region of convergence (ROC), Inverse z-transform, Geometric evaluation of the Fourier transform from the pole-zero plot of First order and Second order systems, Properties of the Z-transform, Analysis and characterization of LTI systems using Z-transform, System function algebra and block diagram representations.	**7**	**15**
	Total	**45**	**100**

Reference Book:

1. Signals & Systems, Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, Second Edition, PHI publications.
2. Signals and Sytems, Simon Haykin and Barry Van Veen, John Wiley and Sons, Second Edition, 2004.
3. Signal and Linear System Analysis, Gordon E. Carlson, Allied Publishers Limited.
4. Signals and Systems, A Anandkumar, PHI publications.
5. Signals and Systems, S Poornachandra and B Sasikala, McGraw Hill Education (India) Pvt. Ltd.

Suggested Course Practical List:

Write the programs in MATLAB/Scilab

1. Generate an impulse, step, and square waveforms in continuous and discrete domain.
2. Generate sinusoidal waveforms of different frequencies in continuous and discrete domain. Understand the difference between CT and DT waveforms.
3. Generate growing exponential, decaying exponential, and exponentially damped sinusoidal signals.
4. Find the discrete/continuous convolution between two sequences/signals. Verify the commutative, distributive and associative properties of convolution.
5. Perform folding, shifting and scaling on a given signal x(t) to obtain a signal of the form x(at+b).
6. Find the output of the system with given input (e.g. x[n]=2 {u[n+2] – u[n-12]}) and given impulse response (e.g. h[n]= 0.9n {u[n+2] – u[n-12] }.
7. Obtain the impulse response h[n] of the systems.
8. Compute FT and DTFT of the continuous time signals and discrete time sequences.
9. Find the partial fraction expansion of the given z-transform.
10. Given an LTI system with transfer function, plot its (i) pole-zero plot in the z-plane and (ii) frequency response.
11. Convert pole-zero gain form of z-transform to second order systems.

List of Laboratory/Learning Resources Required:

1. MIT open courseware, Signals and Systems, Prof. Dennis Freeman https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/
2. NPTEL lectures on signals and systems.
3. Common Lab Manual (DTE)
4. Virtual Laboratory (vLab.co.in)

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point	Duration = 6 h	Based on poster/chart

	preparation on technical topics		preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
3. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
4. All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
5. Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL Branches
Subject Code: BE04000101
Subject Name: Environmental Science, Sustainability and Renewable Energy

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Core Course

Prerequisite:	Interest in natural systems sustaining life on the earth.
Rationale:	This course aims to build environmental awareness and promote sustainable thinking among engineering students. It covers core environmental issues such as pollution, waste management, and climate change, while linking them to global challenges ,need of renewable energy and sustainable development goals (SDGs). Students learn the scientific basis of environmental degradation and the role of engineering solutions in addressing them.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Highlight the importance of environmental sciences.	5%
CO-2	Identify the types of pollution in society along with their sources, causes, effects and mitigation	20%
CO-3	Explain the generation, impacts, and management of various types of wastes and describe the causes and effects of acid rain and ozone layer depletion.	15%
CO-4	Describe the concepts of sustainability, climate change phenomena and green building principles.	30%
CO-5	Recognize the role of Renewable Energy in sustainable development.	30%

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
30	30	0	0	60	2	70	30	20	0	0	120

Content:

Sr. No.	Content	Total Hrs
1	**INTRODUCTION TO ENVIRONMENT** • Definition, principles and scope of Environmental Science. Impacts of technology on Environment, Environmental Degradation, Importance of environmental awareness and its conservation across different engineering disciplines.	02

2	**ENVIRONMENTAL POLLUTION** ● Water Pollution: Introduction – Water Quality Standards, Sources of Water Pollution, Classification of water pollutants, Effects of water pollutants ● Air Pollution: Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like PM, SO_2, NO_X, Auto exhaust, Effects of common air pollutants ● Noise Pollution: Introduction, Sound and Noise, Noise measurements, Causes and Effects ● Land Pollution: Sources, causes, effects, control & Prevention ● Solid Waste: Generation and management ● Bio-medical Waste: Generation and management ● E-waste: Generation and management ● Acid Rain, Depletion of Ozone layer and its mitigation.	10
3	**SUSTAINABILITY:** ● Definition, scope of sustainability, ● Sustainable development & Circular economy, Sustainable Development goals, ● Climate change: Global Warming and Green House Effect: concept and mechanism ● Climate Change Effects and Mitigation Strategies ● Green Building: Concept, Objectives, Core Principles & Benefits. ● Concept of 4R's: Principles, Practical Application of 4R's.	09
4	**RENEWABLE ENERGY:** ● Conventional Vs Renewable Energy, Need of renewable energy ● Advantages, limitations and principles of generation of solar energy, wind energy, hydropower, biomass energy, geothermal energy, tidal energy ● Green Hydrogen: Concept, production, storage, transportation and application	09
	TOTAL	**100%**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
40	**40**	**20**	**00**	**00**	**00**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Basics of Environmental Studies by Prof Dr N S Varandani ,2013 Publisher: LAP - LambertAcademic Publishing , Germany
2. Environmental Studies by Anindita Basak ,2009 Publisher: Drling Kindersley(India)Pvt. LtdPearson
3. Textbook of Environmental Studies by Deeksha Dave & S S Kateva , Cengage Publishers.
4. Environmental Sciences by Daniel B Botkin & Edward A Keller Publisher: John Wiley &Sons.
5. Environmental Studies by R. Rajagopalan, Oxford University Press
6. Environmental Studies by Benny Joseph, TMH publishers
7. Environmental Studies by Dr. Suresh K Dhameja, 2007 Published by : S K Kataria & SonsNew Delhi
8. Basics of Environmental Studies by U K Khare, 2011 Published by Tata McGraw Hill
9. Marco Alvera : The Hydrogen Revolution: a blueprint for the future of clean energy
10. The Energy and Resources Institute (TERI). (2022). *Hydrogen: India's Green Fuel of the Future*. New Delhi: TERI.

List of Tutorials : Based on

1. Introduction to Environment
2. Water Pollution
3. Air Pollution
4. Noise Pollution
5. Solid Waste
6. Bio-medical Waste
7. E-waste
8. Global Environmental Issue
9. Concept of Sustainability
10. Renewable Energy

List of Open Source Software/learning website : MOEF, NPTEL

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code : BE04000111
Subject Name : Analog Signal Processing

WEF Academic Year:	2025-2026
Semester:	4
Category of the Course:	Professional Core

Prerequisite:	1. Fundamental of Basic electronics 2. Electronics devices like transistor, diode etc.
Rationale:	Analog Signal Processing is fundamental to understanding real-time signal behavior in sensors, transducers, and instrumentation systems. It equips the students with essential skills to design and analyze filters, amplifiers, and signal conditioning circuits used in control and measurement applications.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Define and explain DC and AC performance characteristics/parameters of op-amp as well as apply basic voltage regulator ICs for the design of dual power supply.	RM/UN/AP
02	Analyze and design various linear electronic circuits such as DC and AC amplifiers, integrator, differentiator, V to I and I to V converters etc. based on operational amplifiers.	AP/AN
03	Analyze and design various non-linear electronic circuits such as Schmitt trigger, clippers, clampers, precision rectifiers as well as DAC and ADC based on op-amp.	AP/CR
04	Explain, analyze and design various active filters and oscillator circuits using operational amplifier.	UN/AP/CR
05	Explain, analyze and design various special purpose electronic circuits such as monostable and astable multivibrator circuits, instrumentation amplifier, logarithmic amplifier etc. using op-amp as well as specialized ICs such as 555 timer.	AP/AN/CR

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
60	0	30	30	120	04	70	30	20	30	50	200

- **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction to OP-AMP:** 1.1 Basic ideas about: Dual input-balanced output differential amplifier, Inverting and non-inverting inputs, Dual input-unbalanced output differential amplifier, Single input-balanced output differential amplifier, Single input-Unbalanced output differential amplifier. 1.2 Basic introduction to block diagram of a typical op-amp, Basic introduction to equivalent circuit of the 741 op-amp, Schematic symbol and 8 pin functions and power supply of op-amp. 1.3 Open loop op-amp configuration, the differential amplifier, the inverting amplifier, the non-inverting amplifier, positive saturation output, negative saturation output. 1.4 Definition and explanation to the terms of op-amp as:- Input offset voltage, Input offset current, Input bias current, Total output offset voltage, Thermal drift, Differential input resistor, Input capacitance, Offset voltage adjustment range, Input voltage range, Common mode rejection ratio, Supply voltage rejection ratio, Output voltage swing, Output resistance, Output short circuit current, Supply current, Slew Rate.	10	18

2	**An Op-amp with Negative Feedback (Closed Loop):** 2.1 Introduction, Block diagram representation of feedback configuration 2.2 Voltage series feedback amplifier (Non-inverting amplifier with feedback), Derivation of closed loop voltage gain, Input resistance with feedback, Output resistance with feedback, Bandwidth with feedback, Total output offset voltage with feedback, Voltage follower. Voltage shunt feedback amplifier (Inverting amplifier with feedback), Derivation of closed loop voltage gain, Input resistance with feedback, Output resistance with feedback, Bandwidth with feedback, Total output offset voltage with feedback, Current to voltage converter. Differential amplifier with one op-amp Differential amplifier with two op-amp	8	13
3	**General Linear Application:** 3.1 DC Amplifier - Inverting amplifier, Non-inverting amplifier, Differential amplifier - Inverting amplifier with external offset voltage-compensating network, Non- inverting amplifier with external offset voltage-compensating network, Differential amplifier with external offset voltage compensating network. 3.2 AC Amplifier - AC inverting Amplifier - AC non-inverting Amplifier 3.3 The Peaking Amplifier 3.4 Summing Scaling and Averaging Amplifier - Inverting configuration:- Summing amplifier, Scaling amplifier, Averaging amplifier - Non-inverting configuration:- Summing amplifier, Averaging amplifier - Differential configuration:- A subtractor, Summing amplifier 3.5 Voltage to Current Converter with Floating Load 3.6 Voltage to Current Converter with Grounded Load 3.7 Current to Voltage Converter 3.8 Very High Input Impedance Circuit - DC-coupled voltage follower - AC-coupled voltage follower with input resistance bootstrapped 3.9 The Integrator, with its 0db gain frequency (fb) and gain limiting frequency derivation(fa) 3.10 The Differentiator, with its 0db gain frequency(fa) and gain limiting frequency derivation(fb)	10	17
4	**Comparators and Converters:**	8	13

	4.1 Basic comparator, Zero crossing detector, Schmitt trigger 4.2 Comparator characteristics, Limitation of OP-AMP as comparator 4.3 OP-AMP as voltage limiter:- Positive voltage limiter and Negative voltage limiter 4.4 CLIPPER - Positive clippers, Negative clippers - Small signal half wave rectifiers 4.5 CLAMPERS Positive and negative clampers 4.6 Absolute value output circuit, Peak detector, Sample and hold circuit 4.7 Digital to Analog Converter (DAC) - D/A converter with binary-weighted resistor - D/A converter with R and 2R resistor 4.8 Analog to Digital Converters (ADC) - Successive approximation A/D converter		
5	**Active and Passive Filters:** 5.1 Introduction to active and passive filters, Introduction to low pass and high pass filters 5.2 Low Pass Filters - Passive first order low pass filter with its transfer function - Active first order low pass Butterworth filter with its transfer function, filter design - Active second order low pass Butterworth filter with transfer function, filter design 5.3 High pass Filters - Passive first order high pass filter with its transfer function - Active first order high pass Butterworth filter with its transfer function, filter design - Active second order high pass Butterworth filter with transfer function, filter design 5.4 Higher Order Active Filters:- Third order and fourth order low pass Butterworth filter 5.5 Band Pass Filters :-1) Wide band Pass filter and 2)Narrow band pass filters 5.6 Band–Reject Filters:-1)Wideband-reject filter and 2) Narrow band-reject filter (Notch Filter) 5.7 All Pass Filter	8	13
6	**OSCILLATORS:** 6.1 Introduction to oscillator, Oscillator principles, Oscillator block diagram 6.2 Phase shift oscillator, Wien bridge oscillator, Quadrature	8	13

	oscillator, 6.3 Voltage-controlled oscillator NE/SE566		
7	**Specialized IC Applications:** 7.1 The555 Timer Introduction to 555 timer IC, 555 timer pin connection diagram and block diagram 555 timer as a monostable multivibrator:- Operation and circuit diagram - Mono stable multivibrator applications:- 1) Frequency divider 2) Pulse stretcher - 555 timer as an astable multivibrator :- Operation and circuit diagram Astable multivibrator applications :- 1) Square wave oscillator 2) Ramp generator 7.2 Instrumentation amplifier 7.3 Logarithmic amplifier	8	13
	Total	**60**	**100**

Reference Book:

1. Op-amps and Linear Integrated Circuits by Ramakant A. Gayakward, Prentice Hall India.
2. Operational Amplifiers and Linear Integrated Circuits, Robert F. Coughlin, Prentice Hall Publication.
3. Design with operational amplifiers and Analog integrated circuits by Sergio Franco, McGraw Hill

Suggested Course Practical List:

1. To study and perform inverting and non-inverting and differential amplifier using op-amp without feedback.
2. To study and perform offset voltages and its compensation network.
3. To study and perform CMRR configuration and its compensation network.
4. To study the effect of temperature co-efficient and its compensation network
5. To study and perform inverting and non-inverting and differential amplifier using op-amp with feedback.
6. To study and perform summing amplifier and subtractor.
7. To study and perform voltage to current converter with grounded load and with floating load.
8. To study and perform current to voltage converter.
9. To study and perform comparator circuit using op-amp and make PWM wave forms.
10. To study and perform Schmitt trigger circuit using op-amp.
11. To study and perform positive and negative clippers.

12. To study and perform positive and negative clampers.
13. To study and perform the integrator and the differentiator.
14. To study and design first order low pass filter and high pass filter using op-amp.
15. To measure frequency using Wien bridge oscillator.
16. Design and study of monostable, and astable multivibrators using IC555.
17. To study and perform instrumentation amplifier using RTD. Design a Circuit for converting the change in resistance of RTD into 0 to 5 V output with compensation of offset voltages, CMRR and temperature compensation for the range of 30 ˚C to 200 ˚C.

List of Laboratory/Learning Resources Required:

1) DTE Common Lab manual
2) Virtual Laboratory (vlab.co.in)
3) NPTEL/ MOOC Swayam Portal

Activities suggested under Problem Based learning:

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations Based on industry/lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation=5h Total= 10h	Report/presentation based on the video learning outcomes.
3.	Assignment writing. Numerical Based assignment is preferable.	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB,MS-EXCEL or any Other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment At the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2problem. Study of the problem and solution finding, Total= 10h	Based on the depth of the Solution submitted.

7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted
8	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills
10	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration=15hfor industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation=5h Total= 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration=10h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

Note:

- All the suggested activity should be related to the subject.
- Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.

- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code : BE04000121
Subject Name : Control Theory

WEF Academic Year:	2025-2026
Semester:	4
Category of the Course:	Professional Core

Prerequisite:	1. Calculus 2. Ordinary differential equations 3. Complex variables 4. Linear system concepts 5. Laplace transforms.
Rationale:	Control Theory is a core pillar of Instrumentation and Control Engineering, providing the foundational principles for analyzing and designing control systems.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Demonstrate an understanding of the fundamentals of (feedback) control systems.	RM/UN/AP
02	Develop and use models (such as transfer function & state space models) of physical systems in forms suitable for use in the analysis and design of control systems.	AP/AN
03	Investigate and analyze the transient and steady-state responses of feedback control systems to standard test input signals.	AP/AN
04	Apply time domain techniques (such as R-H criteria and root locus) to determine and analyze the stability of a closed-loop control system.	AP/AN
05	Apply frequency domain techniques (such as Bode plot and Nyquist plot) to determine and analyze the stability of a closed-loop control system.	AP/AN

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
60	0	30	30	120	04	70	30	20	30	50	200

- **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction to Control Systems** Introduction Brief History of Automatic Control Examples of Control Systems Engineering Design Control System Design Mechatronic Systems Green Engineering The Future Evolution of Control Systems Design Examples Sequential Design Example	**3**	**5**
2	**Mathematical Models of Systems** Introduction Differential Equations of Physical Systems Linear Approximations of Physical Systems The Laplace Transform The Transfer Function of Linear Systems Block Diagram Models Signal-Flow Graph Models Design Examples The Simulation of Systems Using Control Design Software Sequential Design Example	**9**	**15**
3	**State Variable Models** Introduction The State Variables of a Dynamic System The State Differential Equation Signal-Flow Graph and Block Diagram Models Alternative Signal-Flow Graph and Block Diagram Models The Transfer Function from the State Equation The Time Response and the State Transition Matrix Design Examples	**6**	**10**

	Analysis of State Variable Models Using Control Design Software Sequential Design Example		
4	**Feedback Control System Characteristics** Introduction Error Signal Analysis Sensitivity of Control Systems to Parameter Variations Disturbance Signals in a Feedback Control System Control of the Transient Response Steady-State Error The Cost of Feedback Design Examples Control System Characteristics Using Control Design Software Sequential Design Example	**4**	**7**
5	**The Performance of Feedback Control Systems** Introduction Test Input Signals Performance of Second-Order Systems Effects of a Third Pole and a Zero on the Second-Order System Response The S-Plane Root Location and the Transient Response The Steady-State Error of Feedback Control Systems Performance Indices The Simplification of Linear Systems Design Examples System Performance Using Control Design Software Sequential Design Example	**8**	**14**
6	**The Stability of Linear Feedback Systems** The Concept of Stability The Routh-Hurwitz Stability Criterion The Relative Stability of Feedback Control Systems The Stability of State Variable Systems Design Examples System Stability Using Control Design Software Sequential Design Example	**5**	**8**
7	**The Root Locus Method** Introduction The Root Locus Concept The Root Locus Procedure Parameter Design by the Root Locus Method Sensitivity and the Root Locus Negative Gain Root Locus	**10**	**16**

	Design Examples The Root Locus Using Control Design Software Sequential Design Example		
8	**Frequency Response Methods** Introduction Frequency Response Plots Frequency Response Measurements Performance Specifications in the Frequency Domain Log Magnitude and Phase Diagrams Design Examples Frequency Response Methods Using Control Design Software Sequential Design Example	**7**	**12**
9	**Stability in the Frequency Domain** Introduction Mapping Contours in the s-Plane The Nyquist Criterion Relative Stability and the Nyquist Criterion Time-Domain Performance Criteria in the Frequency Domain System Bandwidth The Stability of Control Systems with Time Delays Design Examples Stability in the Frequency Domain Using Control Design Software Sequential Design Example*	**8**	**13**
	Total	**60**	**100**

Reference Book:

1. Richard C. Dorf & Robert H. Bishop: Modern Control Systems, 13th Edition, Pearson, 2017
2. Norman S. Nise, Control Systems Engineering, Wiley India, Student Edition (Fifth), 2009
3. NAGRATH & GOPAL: Control system engineering, New age International Publication (1996)
4. B.C. KUO: Automatic control systems, Prentice Hall of India Ltd, 1995

Suggested Course Practical List:

1. The Simulation of Systems and models Using Control Design Software.
2. Analysis of State Variable Models Using Control Design Software
3. Analysis of Control System Characteristics Using Control Design Software
4. Identification of System Performance Using Control Design Software
5. System Stability analysis Using Control Design Software

6. The Root Locus plots and analysis study Using Control Design Software
7. Frequency Response Methods analysis study Using Control Design Software
8. Stability analysis in the Frequency Domain Using Control Design Software
9. Find Unit step, ramp, and impulse response of first and second order system using Control Design Software.
10. Derive the open loop and closed loop poles and zeros for varieties of the systems. Draw their Polezero map and check the system stability
11. Draw the step response of over damped, under damped and critically damped system for the second order system having different value of damping factor.
12. Find out time domain specification of second order system using Control Design Software.

List of Laboratory/Learning Resources Required:

1) DTE Common Lab manual
2) Virtual Laboratory (vlab.co.in)
3) NPTEL/ MOOC Swayam Portal

Activities suggested under Problem Based Learning:

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations Based on industry/lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation=5h Total= 10h	Report/presentation based on the video learning outcomes.
3.	Assignment writing. Numerical Based assignment is preferable.	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB,MS-EXCEL or any Other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment At the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2problem. Study of the problem and	Based on the depth of the Solution submitted.

		solution finding, Total= 10h	
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted
8	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills
10	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration=15hfor industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation=5h Total= 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration=10h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

Note:

- All the suggested activity should be related to the subject.
- Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.

- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE04000131
Subject Name: Python for Engineers

WEF Academic Year:	2024 - 2025
Semester:	4
Category of the Course:	Professional Core Course

Prerequisite:	Fundamentals of computer operation, algorithmic thinking, and basic mathematical concepts such as variables, operators, and logical expressions.
Rationale:	Python is a versatile and beginner-friendly programming language widely used in engineering, data science, automation, and web development. Introducing Python at an early stage equips students with essential computational thinking and problem-solving skills, enabling them to design efficient algorithms and develop practical software solutions across various engineering domains.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Understand the basic concepts of Python such as variables, data types, and operators.	RM/UN
02	Understand and apply decision-making statements and loops to solve simple problems.	UN/AP
03	Create and use functions, modules, and packages in Python programs.	CR
04	Understand file handling and write programs to read, write, and handle files and errors.	UN/AP
05	Create programs using Python libraries like Pandas, NumPy, and Matplotlib to work with data and make basic visualizations.	AP/CR

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction, Data Types and Operators:** Installation and working with Python, Variables and data types in python, perform computations and create logical statements using Python's operators: Arithmetic, Assignment, Comparison, Logical, Membership, Identity, Bitwise operators, list, tuple and string operations	10	22
2	**Python Decision making and Loops:** Write conditional statements using If statement, if ...else statement, elif statement and Boolean expressions, While loop, For loop, Nested Loop, Infinite loop, Break statement, continue statement, Pass statement, use for and while loops along with useful built-in functions to iterate over and manipulate lists, sets, and dictionaries. Plotting data, Programs using decision making and loops.	10	22
3	**Python Functions and Modules:** Defining custom functions, Organizing Python codes using functions, Create and reference variables using the appropriate scope, Basic skills for working with lists, tuples, work with dates and times, get started with dictionaries, Importing own module as well as external modules, Programming using functions, modules and external packages	10	22
4	**Python File Operations:** An introduction to file I/O, use text files, use CSV files, use binary files, Handle a single exception, handle multiple exceptions, Illustrative programs, Exercises	5	12
5	**Python Libraries:** **Pandas:** Introduction, Data structure- series in pandas- creation of series from dictionary, Accessing elements of series – Indexing & slicing, Mathematical operations on two series- addition, subtraction, multiplication, division. Dataframes- Creation of data frame- empty, from NumPy, from list of dictionaries, from series, from dictionary of series, operations on rows & columns in dataframes. **NumPy:** Creating NumPy arrays, NumPy array indexing, element wise operations like addition, subtraction, multiplication and division on NumPy arrays. Unary operation, binary operation, NumPy ufuncs, sorting arrays, operation on matrix. **Matplotlib:** Line plot, Bar chart, scatter plot, plotting images and multiple subplots.	10	22
	Total	**45**	**100**

Reference Book:

1. "Introduction to Python for Science and Engineering" by David J. Pine, CRC Press.
2. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India
3. Python Programming Fundamentals- A Beginner's Handbook by Nischay Kumar Hegde
4. Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication
5. Introduction to Python for Engineers and Scientists, By. Sandeep Nagar, Apress
6. "Python Data Science Handbook", by Jake VanderPlas, O'Reilly Media

Suggested Course Practical List:

1. Write a program to demonstrate Python variables, data types, and basic input/output.
2. Write a program to perform arithmetic, logical, relational, identity, membership, and bitwise operations.
3. Write a program to demonstrate list, tuple, and string operations (indexing, slicing, updating, deleting).
4. Write a program using if, if-else, and if-elif statements to check number properties (e.g., even/odd, largest of three).
5. Write a program to demonstrate the use of for loop and while loop with examples like factorial, prime check, etc.
6. Write a program to use break, continue, and pass statements in loops.
7. Write a program to demonstrate functions: with/without arguments, return values, and scope of variables.
8. Create your own module and import it in another Python file.
9. Write a program to demonstrate working with lists, tuples, dictionaries (create, access, modify).
10. Write a program to demonstrate file handling: read/write text files.
11. Write a program to read from and write to a CSV file.
12. Write a program to handle exceptions using try, except, finally, and multiple exceptions.
13. Write a program using NumPy for array creation, indexing, slicing, and basic operations (add, subtract, multiply).
14. Write a program using Pandas to create and manipulate Series and DataFrames.
15. Write a program using Matplotlib to plot line graphs, bar charts, and scatter plots with labels and legends.

List of Laboratory/Learning Resources Required:

1. Common Lab Manual (DTE)
2. Virtual Laboratory (vLab.co.in)
3. NPTEL Website

- **Activities suggested under Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB,	5 small coding-based assignment of 2h each.	Based on the coding solution submitted.
	MATLAB, MS-EXCEL or any other relevant software	Total = 10h	
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions

12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

- All the suggested activities should be related to the subject.
- Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04000141

Subject Name : Microprocessor and Interfacing

WEF Academic Year:	2024 - 2025
Semester:	4
Category of the Course:	Professional Core Course

Prerequisite :	Students should have in depth knowledge of Digital Logic Design.
Rationale :	Microprocessor 8085 has simple architecture and an adequate instruction set that enables students to learn necessary architecture, programming and interfacing concepts. The concepts are easily transferable from this device to the microcontrollers, which are widely used in the field of industrial automation.

Course Outcome:

After Completion of the Course, Student will able to:

CO No.	Course Outcome Statement	Bloom's Level
CO-1	Explain the architecture and operation of the 8085 microprocessor, including memory, I/O, and system bus concepts.	(U)
CO-2	Develop and simulate assembly language programs using data transfer, arithmetic, logic, and control instructions.	(A),(C)
CO-3	Implement counters, delays, subroutines, and code conversions using 8085 ALP.	(A)
CO-4	Interface and program peripheral devices such as ADC, DAC, 8255, and 8253 with 8085.	(AN),(A)
CO-5	Troubleshoot and debug memory and I/O interfacing problems using systematic testing methods.	(E),(AN)

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
60	0	30	30	120	04	70	30	20	30	50	200

- **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr. No.	Content	Total Hrs	Percentage
1	**Introduction to Microcomputers and Microprocessors** Introduction to digital computer, Computer languages, Operating systems, Data representation, Microprocessor organization, Memory, Input/output devices, System bus, Microprocessor controlled temperature system.	4	10%
2	**Microprocessor Architecture and Microcomputer Systems** Microprocessor 8085 architecture and its operations, Registers, Flags, Memory, Input/output and interfacing devices, Pin diagram, Bus timings, Demultiplexing the address/data bus, Control signals, 8085 based microcomputer, Interfacing memory, Interfacing input & output (I/O) devices, Memory mapped I/O, Testing and Troubleshooting of memory and I/O interfacing circuits.	12	20%
3	**Instructions and Timings** Programming model, Data transfer, arithmetic, logical, branch and machine control instructions, Instruction format, Addressing modes, Timing diagram of single byte, two byte, three byte instructions.	10	15%
4	**Assembly Language Programming (ALP)** Looping, counting, and indexing, Programming using data transfer, arithmetic, logical and branching instructions, Counters and time delays, Stack and Subroutine, Code conversion, BCD arithmetic and 16-bit data operations.	16	25%
5	**Interrupts** Basic understanding of interrupt process, Vector interrupts, Software interrupt.	4	10%
6	**Interfacing** DAC and ADC, 8255A programmable peripheral interface (PPI) mode 0 and BSR mode, Seven segment multiplexed display and matrix keyboard interfacing using 8255, 8253 programmable interval timer.	14	20%

Reference Books:

1. Microprocessor Architecture, Programming, and Applications with the 8085 - Ramesh S. Gaonkar Penram International Publishing (India) Pvt. Ltd.
2. Microcomputers and Microprocessors: The 8080, 8085 and Z-80 Programming, Interfacing and Troubleshooting by John E. Uffenbeck.
3. Microprocessor and Microcontroller fundamentals. The 8085 and 8051 Hardware and Software by William Kleitz.
4. 0000 to 8085 – Introduction to Microprocessors for Engineers and Scientists,P. K. Ghosh and P.R. Shridhar, Prentice hall of India Pvt. Ltd, 2nd edition.
5. The 8085 Microprocessor: Architecture, Programming and Interfacing, K. Udaya Kumar and B.S.Umashankar, Pearson Education

Suggested Course Practical List:

Sr. No.	Practical Title	Mapped CO(s)
1	Introduction to 8085 Microprocessor Trainer Kit and identifying I/O and memory components	CO1
2	Introduction to 8085 Simulator IDE and debugging features like breakpoints and watch registers	CO1
3	Assembly language program using data transfer instructions (MOV, MVI, LXI, etc.)	CO2
4	Assembly language program using arithmetic instructions (ADD, SUB, INR, DCR, etc.)	CO2
5	Assembly language program using logical instructions (ANA, ORA, XRA, CMA, etc.)	CO2
6	Assembly language program using branching and looping instructions (JMP, JNZ, JC, etc.)	CO2, CO3
7	Assembly language program using counters and software delays	CO3
8	Assembly language program using Stack and Subroutine (CALL, RET, PUSH, POP)	CO3
9	Assembly language program for Code Conversion (Binary to BCD, Hex to ASCII, etc.)	CO3
10	Assembly language program for BCD arithmetic and 16-bit operations	CO3
11	Interfacing of ADC with 8085 and displaying analog value in digital format	CO4
12	Interfacing of DAC with 8085 for waveform generation (e.g., ramp/sawtooth)	CO4
13	Interfacing 8255 PPI in Mode 0 and BSR Mode with LED or 7-segment display	CO4
14	Interfacing matrix keyboard using 8255 and writing ALP to detect key pressed	CO4
15	Interfacing and programming of 8253 timer for square wave generation or delay-based control	CO4, CO5

List of Laboratory/Learning Resources Required:

- 8085 microprocessor trainer kit with peripheral devices
- Computer system
- CRO, Power supply

List of Open Source Software/learning website:

- 8085 simulator
- nptel.ac.in

Activities suggested under Problem Based Learning:

Sr. No.	Name of the Activity	No. of Hours	Evaluation Criteria
1	Watch NPTEL lectures on "8085 Architecture and Programming" and prepare a summary	2 hours	Summary report / Oral viva
2	Study and compare instruction timing diagrams of single, two, and three-byte instructions	2 hours	Written explanation / MCQ quiz
3	Simulate 8085 programs using online/open-source simulators (e.g., GNUSim8085, BCU)	3 hours	Simulation screenshots and output log submission
4	Create and share a tutorial video explaining ALP using arithmetic and logic instructions	3 hours	Peer feedback and faculty review
5	Analyze the working of ADC/DAC interfacing circuits and present a report	3 hours	Report with circuit explanation and block diagram

Note:

- All the suggested activity should be related to the subject.
- Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code : BE04000151
Subject Name : Industrial Measurment - 1

WEF Academic Year:	2025-2026
Semester:	4
Category of the Course:	Basic Science Course

Prerequisite:	Basic concept of Measurement
Rationale:	Industrial Instrumentation is an important part of industry that deals with the measuring of variables that influence materials production and equipment during the development of a product. Every Instrument engineers has to deal with various types of Instruments in the working environment. This course describes the working principles of these measuring instruments.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	To classify different types of sensors and transducers.	UN
02	To identify sensor for a particular application	AP
03	To analyze application and output of various sensors and transducers	AN
04	To explain smart sensors basics and its performance	EL
05	To build a product/ instrument system based on application or problem statement	CR

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching-Learning Scheme (inHours perSemester)					Total Credits = TH/30	AssessmentPatternandMarks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

- **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Basics of transducers and its classification:** Definition and block diagram of instrumentation and measurement system, Characteristics of an instrument and its classification, Static characteristics: accuracy, precision, resolution, sensitivity, scale, threshold, hysteresis, drift, dead zone, repeatability, reproducibility and error and its classification, Dynamic Characteristics: Speed of response, lag, fidelity and error, Transducer and sensors and their difference and classification.	2	4
2	**Temperature Measurement:** Definition, Scales, Selection Criteria, Calibration, classification of different types of temperature sensors, Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Thermometer: Mercury and Digital, RTD, Thermocouple, Thermister, Bimetallic Thermometer, Pyrometers: Optical and Radiation.	8	18
3	**Pressure Measurement:** Definitions of pressure and its types, scales, selection criteria, calibration, classification of different type of pressure sensors, Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Manometers, Bourdon tube, bellows and diaphragm gauges, primary pressure measurement, secondary pressure measurement using LVDT and Capacitance and differential pressure measurement, vacuum pressure measurement: McLeod Gauge, Thermal conductivity gauges, ionization gauges and Knudsen gauges, Strain gauges and Load cell, dead weight tester.	8	18
4	**Level Measurement:** Definition, Scales, Selection Criteria, Calibration, classification of different types of level sensors, , Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Resistance, Inductance and Capacitance Level Measurement, Float, displacer and air purge bubbler type level measurement, Ultrasonic and radar level measurement, Nuclear radiation method of level measurement and its detectors like Geiger Muller, Ionization and scintillation counters, Solid Level Measurement.	8	18
5	**Flow Measurement:** Definition and classification of flow, Scales, Selection Criteria, Calibration, Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Head type: Orifice, Venturi,	8	18

	Pitot tube and flow nozzle, Area type: Roatameter and piston type, Mass flow meters: Turbine, Coriolis and calorimetric type, Positive displacement type: Nutating disc, rotary vane, Lobed impeller and reciprocating piston, Electrical types: Eletromagnetic, Ultrasonic and hotwire anemometer, Digital type: Vortex and flow marker type, Open channel type and Solid flow meters.		
6	**Smart Sensors:** Introduction, Primary Sensors, Excitation, Amplification, filters, Converters, Compensation: Non Linearity, Noise and Interference, Response time, drift, cross sensitivity, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface and The Automation	6	13
7	**Recent Trends in Sensor Technologies:** Introduction, Film Sensors: Thick Film Sensors and Thin Film Sensors, Semiconductor IC Technology - Standard Methods, Microelectromechanical systems (MEMS): Micromachining and some application examples and Nano Sensors	5	11
	Total	**45**	**100**

Reference Book:

1. Instrument Engineers' Handbook: Process Measurement and Analysis by B. G Liptak.
2. Principles of Industrial Instrumentation by D. Patranabis, McGraw – Hill Publication.
3. Sensors and Transducers by D. Patranabis, Second Edition, PHI Publication
4. Handbook of Applied Instrumentation by D. M. Considine and Sidney David Ross, McGraw – Hill Publication.
5. Encyclopedia of Instrumentation and Control by D. M. Considine, Kriege Publication Co.
6. Instrumentation Reference Book by Walt Boyes, Butterworth – Heinemann Publisher.
7. Industrial Instrumentation by K. Krishnaswamy and S. Vijayachitra, New Age International Publication.
8. Measurement Systems: Application and Design by E. O. Doeblin, McGraw – Hill Publication
9. Understanding smart sensor by Randy Frank, Artech House.

Suggested Course Practical List:

1. To study about the bourdon tube gauge for pressure measurement.
2. To perform pressure measurement using calibrated pressure Sensor
3. To perform temperature measurement using an IC sensor as temperature
4. To perform temperature measurement using RTD as temperature transducer along with its signal Conditioning.
5. To perform temperature measurement using Thermister as temperature transducer.
6. To perform Temperature measurement using Thermocouple as temperature transducer.
7. To perform temperature measurement using a Radiation type pyrometer
8. To perform level measurement using capacitance method.
9. To measure flow of stream using Orifice Plate using VLab Simulator.
10. To test and calibrate a given pressure gauge using dead weight tester.

List of Laboratory/Learning Resources Required:

1) DTE Common Lab manual
2) Virtual Laboratory (vlab.co.in)
3) NPTEL/ MOOC Swayam Portal

Activities suggested under Problem Based Learning:

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations Based on industry/lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation=5h Total= 10h	Report/presentation based on the video learning outcomes.
3.	Assignment writing. Numerical Based assignment is preferable.	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB,MS-EXCEL or any Other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment At the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2problem. Study of the problem and solution finding, Total= 10h	Based on the depth of the Solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted
8	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills
10	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation

11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration=15hfor industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation=5h Total= 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration=10h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

Note:

- All the suggested activity should be related to the subject.
- Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL
Subject Code: BE05000011
Subject Name: Societal Internship

w.e.f. Academic Year:	2024-25
Semester:	5 (To be done in between 4th and 5th semester)
Category of the Course:	Project

Prerequisite:	-
Rationale:	The *Societal Internship* fosters experiential learning and community engagement, aligning with NEP 2020. It exposes engineering students to real societal challenges, encouraging empathy, collaboration, and socio- technical problem- solving. By bridging classroom knowledge with community realities, it nurtures socially responsible engineers committed to sustainable development, inclusivity, and ethical citizenship.

1.0 Framework for the course

1.1 NEP 2020 envisions Higher Educational Institutes to be centres with high quality teaching, research and community engagement (Sec 10). It emphasizes holistic and multidisciplinary education, experiential learning, community engagement, & development of socially responsible engineers (Sec 11).

1.2 In line with this, the 2-week societal internship provides students with structured exposure to real social challenges, enabling them to apply their technical thinking, develop empathy, and learn contributorship in authentic contexts (in alignment with the CPDP program).

1.3 **Total duration**: 2 weeks (10–12 field days)

1.4 Mode: Field-based team internship with guided mentoring and reflection sessions.

Course Outcome:

After Completion of the Course, Students will be able to:

No	Course Outcomes
01	Demonstrate sensitivity towards socio-economic and cultural realities of diverse communities.
02	Identify and articulate community challenges by engaging with multiple stakeholders.
03	Apply engineering knowledge and problem-solving skills to collaboratively design socio-technical solutions.
04	Participate meaningfully with government departments, NGOs, and grassroots institutions to understand societal processes.
05	Communicate observations, insights, and contributions effectively through structured field diaries, presentations, and reports.

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
0	0	60	0	60	02	0	0	20	0	80	100

- *Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.*

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

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3. Format of the Course (Indicative)

Faculty will pre-identify some themes suitable in their local context.

Some triggers to think about the themes

3.1 Environmental: pollution management, energy/ resource conservation, weather and bio- diversity documentation, etc.

3.2 Civic: waste management, public transport management, health monitoring, etc.

3.3 Local industry: engineering needs for industries in any MSMEs, textiles, agriculture & food processing, diamonds, chemicals, etc. (some of the students' families may be involved in these)

3.4 In-college: academic processes and academic ambience, green campus, and energy efficiency in campus".

Structure

Students will work in their teams based on themes they are interested in. The Internship can be structured in 3 intensive phases.

Phases	Details of the activities
Orientation and Proposal (3 days): Introductory sessions on the scope and purpose of the course, and guidelines on community engagement and research and implementation ethics	Students will – Have a clear picture of the objective of the internship – Organize themselves to engage with the community sensitively – Make a proposal document with their plan: which theme they will work on, which stakeholders in the community they will interact with, tools and modes of engagement (surveying, interviewing, etc.), plan with timelines etc.
Field work Phase-1 –	Students will

Framing the scope (5-6 days): Choosing the challenge and framing the problem	– Engage with the stakeholders, gather inputs on the challenges, areas of concern, digging deeper to understanding the roots of the challenge, etc. – They will collect, synthesize, and analyze data into insightful inference to make an informed decision or action. – Every day, there can be a 1-hr huddle at the end of the day, to consolidate, present and seek feedback from peers on the progress, and any course-correction. – Make an interim Framing Document (extending the proposal)
Field work Phase-2 – Solution Design (4-5 days): Outlining the solution in some detail, and reflecting on the feasibility and value	Students will – Go to the drawing board and ideate possible solutions or interventions to address these challenges. *They can draw inspirations from any pre-existent approach or solution, that is implemented or tried out elsewhere, by doing quick web research as well.* – Detail out the solution approach doing research online or quick discussions with the relevant stakeholders. *Here they may seek support from faculty of other departments etc, to inform their technical feasibility.* – Work out the feasibility, pros-cons, value-creation for the stakeholder, and probable steps and necessary resources and means to implement this. – Make a Societal Internship Report (extending the framing document) and present the whole field work to the entire college or department. They can be creative in the presentation (may build virtual and real prototypes if necessary)
During Field work phases (esp. phase-1), there can be a 1-hr huddle between 3-4 teams at the end of each day, to consolidate, present and seek feedback from peers on the progress, and any course-correction. *Faculty's role will be primarily participating in these pursuits as an adult facilitator, and not to preach or provide solutions. Where possible, necessary and accessible, external stakeholders can be involved to support/ mentor students.* These daily huddles will also keep the faculty broadly abreast with the developments, and ensure students make steady progress and are broadly safe.	

4. Assessment Scheme

Component	Weightage	Criteria
Initial Proposal	10%	Quality of thinking as reflected in the detailed think-through.
Field Work	40%	Rigour, coordination, discipline and care for the detail in their field engagements and analysis
Final Report	30%	– Quality of thinking, research and articulation – Sensitivity to the realities of the stakeholders – Application of their engineering skills – Feasibility of implementation
Presentation	20%	Clarity and sharpness of insights in the presentation

Some of these can include peer-evaluation and expert/stakeholder evaluation (where possible).

5. Responsibilities of the Faculty

5.1 Identifying possible themes suitable in the community (within and outside the college)

5.2 Conducting orientation sessions

5.3 Facilitating daily huddles to ensure steady and safe progress by all teams in Field work phases

5.4 Mentoring on research and technical aspects, bringing out multi-disciplinary nature

5.5 Evaluating final outputs and certify completion

6. Optional Add-ons (Recommended by NEP)

6.1 Integration with any ongoing community / innovation labs or student chapters

6.2 Opportunity for extended projects during 3rd year and built into Bachelor's project or full- fledged internship in a suitable organization.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Instrumentation and Control / Electronics and Instrumentation
Subject Code : BE05000021
Subject Name : Microcontroller and Interfacing

WEF Academic Year:	2024-2025
Semester:	5
Category of the Course:	Professional Core Course

Prerequisite:	1. Basics of Microprocessor 2. Basics Electronics 3. Digital Electronics
Rationale:	Every electrical and electronics project designed to develop electronic gadgets that can be used in domestic as well industry utilizes microcontrollers with appropriate interfacing devices. Different types of applications are designed using microcontroller-based projects. In a maximum number of applications, the microcontroller is connected with some external devices like keyboard, display, timer etc. called as interfacing devices for performing some specific tasks.

Course Outcome:

Sr. No.	Course Outcomes	Marks% weightage
CO-1	To understand and explain microcontroller architectures (8051), addressing modes, embedded C basics, timers, interrupts and serial communication.	25
CO-2	To develop, debug and analyze programs in Assembly and Embedded C for 8051 microcontrollers.	25
CO-3	To interface external and on-chip peripherals (ADC, DAC, I2C, SPI, displays, sensors) with microcontrollers.	20
CO-4	To analyze timing parameters such as delay, baud rate, instruction execution and configure timers, interrupts, and communication modules.	20
CO-5	To design and implement microcontroller-based industrial/embedded systems as an individual or in a team.	10

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
60	0	30	30	120	04	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction & architecture of 8051 Microcontroller** Definition of Microcontroller, Difference between Microprocessor and Microcontroller, Block diagram of 8051 Microcontroller, Overview of 8051 family 8051 Microcontroller Architecture, Architecture of 8051 Microcontroller, The program counter and ROM space in the 8051, 8051 flag bits and the PSW register, 8051 register banks, stack and RAM Space.	**2**	**4**
2	**8051 Assembly Language Programming:** Introduction to 8051 assembly programming, Structure of Assembly language, Assembling and running an 8051 program, 8051 data types and directives Jump, Loop, And Call Instructions: Loop and jump instructions, Call instructions time delay for various 8051 chips	**4**	**8**
3	**8051 Addressing Modes:** Immediate and register addressing modes, Accessing memory using various Addressing modes, Bit addresses for I/O and RAM, Extra 128-byte on-chip RAM in 8052.	**4**	**8**
4	**Arithmetic and Logic Instructions and Programs:** Arithmetic instructions, Signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instruction and data serialization, BCD, ASCII, and other application programs.	**4**	**5**
5	**I/O Port Programming and Seven Segment Display:** 8051 I/O programming, I/O bit manipulation programming. Internal Structure of ports • Introduction to seven segment display, common cathode and common anode seven segment display • Interfacing of a seven segment display with 8051 and programming to display from 0 to 9 at every second using a loop. • Interfacing of push button and SPST switch with 8051 ports. Introduction to key bouncing and de-bouncing techniques. • Write a program to interface 8 SPST switch and one seven segment display with 8051 and display the number of switch whichever is presses at a time on seven segment display • Generation of square wave on port pin with different duty cycle using loop.	**6**	**7**
6	**8051 Programming in C:** Data types and time delay in 8051 C, I/O programming in 8051 C, Logic operations in 8051 C, Data conversion programs in 8051 C, Accessing code ROM space in 8051 C, Data serialization using 8051 C	**2**	**10**
7	**8051 Hardware Connection and Intel Hex File:** Pin description of the 8051, Design and test of 8051 Minimum Module, Explaining the Intel hex file.	**2**	**10**

8	**8051 Timer Programming in Assembly and C:** Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C. 8051 Serial Port Programming in Assembly and C: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in Assembly, Programming the second serial port, Serial port programming in C. Interrupts Programming in Assembly and C: 8051 interrupts programming, Timer interrupts, Programming external hardware interrupts, Programming the serial communication interrupt, Interrupt priority in the 8051/52, Interrupt programming in C.	**8**	**7**
9	**LCD and Keyboard Interfacing**: LCD interfacing in Assembly and C. Keyboard interfacing in Assembly and C.	**6**	**10**
10	**ADC and DAC interfacing Types of ADC and DAC.** Parallel ADC 0804 and 0808 interfacing with 8051 Parallel DAC 0808 interfacing with 8051, converting Iout to voltage in DAC0808, Generation of sine wave using DAC0808.	**4**	**10**
11	**8051 Interfacing to External Memory:** Memory address decoding, 8031/51 interfacing with external ROM, Flash RAM, 8051 data memory space, Accessing external data memory in 8051 C. 8051 interfacing with 8255 Programming the 8255, 8255 interfacing, 8051 C programming for 8255	**4**	**10**
12	**Motor Control: PWM, DC and Stepper Motors:** Generation of PWM signal using timer in Assembly or C language Interfacing of DC motor with 8051 and control it's speed and direction using PWM Interfacing of Stepper motor with 8051	**4**	**11**
	Total	**60**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**20**	**20**	**5**	**5**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Microcontroller and Interfacing* directly contributes to

SDG 3	Good Health & Well-being
SDG 4	Quality Education
SDG 7	Affordable & Clean Energy
SDG 8	Decent Work & Economic Growth
SDG 9	Industry, Innovation & Infrastructure
SDG 11	Sustainable Cities & Communities
SDG 12	Responsible Consumption & Production
SDG 13	Climate Action

Reference Book:

1. The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2/e by Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay(Second Edition , Pearson Education).
2. The 8051 Microcontroller & Embedded Systems using Assembly and C By K. J. Ayala, D. V. Gadre (Cengage Learning , India Edition).
3. 8051 Microcontrollers: MCS51 family and its variants by Satish Shah, Oxford University Press.
4. 8051 Microcontroller: Internals, Instructions, Programming and Interfacing by Subrata Ghoshal, Pearson Education.
5. The 8051 Microcontrollers: Architecture, Programming and Applications by K Uma Rao, Andhe Pallavi, Pearson Education.
6. INTEL Manual: MCS-51 Architecture.

List of Experiments:

1. To develop and execute assembly and Embedded C programs for performing arithmetic operations (addition, subtraction, multiplication, division, and 16-bit addition) using 8051 microcontroller.
2. To write and test programs for block data transfer and sorting of data (ascending/descending order) using internal and external memory of 8051.
3. To design programs for finding maximum, minimum, and counting even, odd, and zero elements from a given data set using the 8051.
4. To generate time delays and square waveforms with different duty cycles using a loop of 8051.
5. To generate time delay of 1 second using a loop and a timer in 8051
6. To develop a program in assembly for different code conversion
7. To implement serial communication using UART in 8051 for transmitting and receiving data.
8. To interface LED with any port of the 8051 and blink it continuously with a 1-second delay.
9. To interface switches and a seven-segment display with 8051 and implement key detection with a debouncing technique.

10. To interface LCD with 8051 microcontroller and display alphanumeric characters and messages.
11. To interface ADC and DAC (0804/0808) with 8051 microcontroller and perform analog to digital and digital to analog conversion.
12. To control DC motor and stepper motor using 8051 microcontroller with PWM technique.

Major Equipment:

1. 8051 Microcontroller kit
2. Miscellaneous Electronics Components - ADC 0804, DAC 0808, DC Motor, LCD, LED, Keypad, 7- Segment display.

List of Open Source Software

1. Keil Software

List of learning website/ resources:

1) DTE Common Lab manual
2) Virtual Labs by IITs (Government of India Initiative) (https://vlab.co.in/)
3) NPTEL / SWAYAM (https://nptel.ac.in/)
4) INTEL Manual: MCS-51 Architecture.

Activities suggested under self-learning:

Sr. No.	PBL Category	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry / Research Laboratory Visit	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on the report submitted. Report should contain observations and calculations Based on industry/lab data.
2.	Video Based Learning	Technical Video based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5h Report preparation=5 h Total= 10h	Report/presentation based on the video learning outcomes.

3.		Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment At the end of course. Based on the certificate produced.
4.		Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted
5.	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical Based assignment is preferable.	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.
6.		Problem solving/Coding using C, C++, Python, SCILAB, MATLAB,MS-EXCEL or any Other relevant software	5 small coding-based assignments of 2h each. Total = 10h	Based on the coding solution submitted.
7	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total= 10h	Based on the depth of the Solution submitted.
8	Research Paper Review / Analysis	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters
9.	Poster/ Chart/ Power poin presentation	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills

10	Micro Project	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation
11	Group Discussion / Quiz / Simulation	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
12		Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation=5 h Total= 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Other	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Microcontroller and Interfacing* incorporates;
   - Mini Project – 10 Marks
   - Micro Project - 5 Marks
   - Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Instrumentation and Control / Electronics and Instrumentation
Subject Code: BE05000031
Subject Name: Process Control

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Core Course

Prerequisite:	Basic Process Instrumentation, Control Theory, Mathematical Modeling
Rationale:	Process control deals with the science of maintaining the output of a specific process within a desired range. Process control is commonly used for mass production, it enables the automation of industrial processes.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Understand the need of process control, basic principles of various manufacturing processes and apply engineering knowledge to do problem analysis in process control.	30
CO-2	Define common dynamics of processes found in many industries and model them mathematically.	25
CO-3	Select the proper controller and apply the tuning rules to achieve optimum performance	25
CO-4	Understand, interpret and implement tuning of the controllers using various methods and study about digital controllers	10
CO-5	Select advanced control strategy to enhance the performance	10

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Content:

Sr. No.	Content	Total Hrs
1	**INTRODUCTION** Introduction to Process Control. Control objectives, servo regulatory control, and classification of process variables.	3
2	**MODELING OF SOME CHEMICAL PROCESS SYSTEMS** Modeling basics, Degree of Freedom, Mass Balance, Energy Balance equations, linearization of nonlinear systems, Modeling of Level Tank System, Continuous Stirred Tank Heater, Continuous Stirred Tank Reactor, Transfer function.	8
3	**ELEMENTS OF PROCESS CONTROL** Dead time, Interacting and non-interacting systems, self-regulation, inverse response, capacity of process, integrating systems, multi-capacity process.	5
4	**PROCESS IDENTIFICATION** Dynamic behavior of first and second order processes, Obtaining First Order Plus Time Delay (FOPTD) model with Process Reaction curve. Obtaining a second order model of processes.	5
5	**COMMON CONTROLLER MODES** Controller Modes, ON OFF, Multi position, time proportional controller, Theory Proportional, Integral and Derivative modes, PI, PD, PID Controller, Electronics Controller implementation	10
6	**DISCRETISATION AND IMPLEMENTATION ISSUES** Discrete time control mode realization. Velocity and Position algorithm of PID control. Integral windup, anti-windup systems, controller bias, bumps less transfer.	4
7	**TUNING OF CONTROLLERS** Application and tuning, ZN Tuning (Open loop and Closed loop), Performance criteria, Integral criteria	5
8	**SOME ADVANCE CONTROL TECHNIQUES** Cascade Control, Feed forward Control, ratio Control, Air Fuel Ratio Control for Drum Boilers. Level Control in Drum Boiler, Shrinking and Swelling, Inverse response of Drum Boiler. Model predictive control – Concept, Selective and Override Control: block diagram, operation, applications, Split Range Control: block diagram, operation, applications.	5
	TOTAL	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**20**	**20**	**5**	**5**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Process Control* directly contributes to

SDG 7	**Affordable and Clean Energy**
SDG 9	**Industry, Innovation and Infrastructure**
SDG 12	**Responsible Consumption and Production**
SDG 13	**Climate Action**

Reference Books:

1. G. Stephanopolous, "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall India, August 2000.
2. Surekha Bhanot, "Process Control Principles and Applications", Oxford, 2008
3. C.D. Johnson, "Process Control Instrumentation Technology", Prentice Hall India.
4. Thomas Marlin, "Process Control Designing Processes and Control for Dynamic Performance", Tata MC Graw Hill, 2012.
5. F.G. Shinskey, "Process Control Systems Application Design and Adjustment" 3rd editionn, McGraw Hill International.
6. D. E. Seborg, T.F. Edgar, D. A. Mellichamp, "Process Dynamics and Control", Wiley, 2004.

List of Experiments:

1. Introduction to MATLAB/Scilab
2. To find Unit step, ramp, impulse response of first and second order system using MATLAB/Scilab.
3. To implement the ON OFF control with op-amp or other equivalent circuits.
4. Software implementation of On OFF controller using 8051 or equivalent.
5. Understanding FOPTD and SOPTD modeling of systems with MATLAB or SCILAB.
6. Implementation of PI controller with op-amp or other equivalent circuit.
7. Implementation of PID controller with op-amp or other equivalent circuit.
8. To study ZN tuning for a given plant/system with MATLAB or SCILAB.
9. Hardware implementation of closed loop systems with any control system trainer.
10. Implementation of P, PI, PID algorithm with microcontrollers like 8051.
11. Implementation of Cascade Control System.
12. Implementation of feed forward control
13. Implementation of Ratio control
14. Study of industrial grade single loop controller (specifications, configuration, testing, calibration)

Major Equipment:

1. Process Control Trainer Kits (Level, Flow, Temperature, Pressure control systems)
2. PID Controller Hardware Modules / Industrial Single Loop Controllers
3. MATLAB / SCILAB based Control System Simulation Setup

List of Open Source Software

1. **Scilab** (https://www.scilab.org/) – An open-source alternative to MATLAB
2. **GNU Octave** – MATLAB-compatible tool for control system design, simulation, and numerical computations
3. **OpenModelica** – For dynamic modeling and simulation of industrial processes (CSTR, tank systems, energy systems)
4. **Xcos** – Block diagram-based simulation tool for control systems (similar to Simulink)

List of learning website/ resources:

1. DTE Common lab manual
2. Virtual Labs by IITs (Government of India Initiative) (https://vlab.co.in/) – Simulations and experiments related to Power electronics.
3. Reputed Research Journal Website
4. NPTEL / SWAYAM (https://nptel.ac.in/)

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Visit to process industries (chemical plant, thermal plant, automation industry) to study real-time control systems like level, flow, temperature control	Visit = 5 hrs, Report = 5 hrs (Total = 10 hrs)	Based on report quality, observations, and understanding of industrial control systems
2	Video Based Learning	Technical video learning (NPTEL/MOOC) on PID control, process dynamics, and industrial automation	Video = 5 hrs, Report = 5 hrs (Total = 10 hrs)	Report/presentation based on learning outcomes and conceptual clarity
3	Self-Learning Online Course	Online certification course on process control / industrial automation / PLC-SCADA	Minimum 10 hrs	Based on certificate and assessment performance
4	Annotated Video Explanation	Prepare and record explanation of concepts like FOPTD model, PID tuning, or cascade control	10 hrs	Based on clarity, accuracy, and presentation quality
5	Assignment / Technical Writing	Numerical assignments on modeling, controller design, and tuning methods	5 assignments × 2 hrs = 10 hrs	Based on correctness and problem-solving approach
6	Blog / Technical Article Writing	Write article on topics like Industry 4.0 in process control, smart controllers, or MPC	10 hrs (Research + Writing)	Based on originality, technical depth, and references

7	Complex Problem Solving / Mini Project	Solve real-world problems like temperature control of reactor, tank level control, or boiler control optimization	15 hrs	Based on solution depth and application of control concepts
8	Research Paper Review / Analysis	Review SCOPUS/IEEE papers on advanced control techniques like MPC or AI-based control	20 hrs	Based on understanding, summary, and critical analysis
9	Poster / PPT Presentation	Prepare poster/PPT on PID tuning methods, industrial case studies, or advanced control strategies	6 hrs	Based on presentation skills and technical content
10	Micro Project	Develop working/non-working model (e.g., temperature control system using microcontroller or simulation model in MATLAB/Scilab)	10 hrs	Based on implementation, innovation, and demonstration
11	Group Discussion / Quiz / Simulation	Group discussion on trending topics like smart industries, digital control systems, Industry 4.0	1 hr each / total 10 hrs	Based on participation, knowledge, and technical depth
12	Case Study Analysis / Seminar	Analyze real-world case studies of industrial process control failures/success (e.g., boiler control, chemical reactor control)	10 hrs	Based on depth of study, analysis, and reporting
13	Patent Search & Innovation	Identify patents related to control systems and find innovation gaps in process industries	10 hrs	Based on number of patents analyzed and innovation identification

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Process Control* incorporates;

- Mini Project – 10 Marks ,Micro Project – 5 Marks, Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Instrumentation and Control / Electronics and Instrumentation
Subject Code : BE05000041
Subject Name : Industrial Measurement II

WEF Academic Year:	2024 -2025
Semester:	5
Category of the Course:	Professional Core Course

Prerequisite:	Basics of Sensors and Transducers, Basics of Measurement and Instruments,
Rationale:	Industrial measuring instruments are critical for maintaining process control and ensuring product quality in diverse manufacturing environments. As a continuation of 'Industrial Measurement I', this course introduces miscellaneous and advanced measurement techniques, preparing students to handle complex instrumentation setups in real-world industrial applications.

Course Outcome:

Sr. No	Course Outcomes	Marks Weightage %
CO-1	Explain the working principles, construction details, and applications of instruments used for measuring humidity, moisture, density, and viscosity in industrial environments.	20
CO-2	Select appropriate sensors and transducers for the accurate measurement of force, torque, displacement, and stress-strain in varied engineering applications.	20
CO-3	Analyze the performance characteristics and operational suitability of measurement systems utilized for kinematic and dynamic variables such as speed, velocity, acceleration, and vibration.	20
CO-4	Evaluate acoustic measurement systems and interpret the advancements in modern sensor technologies, including smart sensors and microsensors.	20
CO-5	Conduct laboratory experiments to measure physical parameters, calibrate industrial instruments, and interpret the resulting data to troubleshoot process instrumentation setups.	20

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Humidity Measurement** Definition and Block Diagram of Humidity, Dew Point, Absolute Humidity and Relative Humidity. Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of humidity measurement using psychrometer, Measurement using Hygrometer: Mechanical (Wood and Hair)Hygrometers, dunmore cells, Pope Cells, dew point meter - Surface Conductivity Method and Optical Chilled Mirror Method, Lithium Chloride Dew Point Sensor, Electrolytic Hygrometers	**5**	**11**
2	**Moisture Measurement** Definition of Moisture, Percent Moisture Content **Measurement of Moisture in Gases and Liquids:** Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Electrolytic Hygrometer, Capacitance Hygrometer, Impedance Hygrometer, Piezoelectric Hygrometer, Heat of adsorption Hygrometer, Infrared absorption Hygrometer, Microwave absorption Hygrometer. **Measurement of Moisture in Solids:** Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Nuclear Moisture Gauge, Infrared Absorption or Reflection Moisture Gauge, Microwave Solid Moisture Analyser, Capacitance Moisture Gauge, Conductance or Resistance) Moisture Gauge.	**7**	**16**
3	**Force (Weight) and Torque:** Definitions of Weight, force, torque, Mass, specific gravity; **Force Measurement** - Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Mechanical Balances (Analytical, Pendulum and Platform Scale), Accelerometer, Electromagnetic Balance, Mechanical Load Cells (Hydraulic and Pneumatic), Elastic Deflection (Strain Gauge, Piezo Resistive Inductive and Reluctance and Magnetostrictive), Gyroscopic, Vibrating Wire, Nuclear Radiation, Weigh Feeder. **Torque Measurement** - Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Rotating	**6**	**13**

	Torque Sensors, Stationary Sensors, Reaction Torque Sensor, Torsion Bar Torquemeter, Torque Measurement using Proximity Sensors.		
4	**Displacement Measurement:** Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Resistance - Potentiometer (Linear and Angular displacement) and Strain Gauge; Inductor Transducer - LVDT and RVDT Capacitance Gauge; Piezoelectric transducer; Eddy Current Transducer;Hall-effect Transducer; Proximity Sensor - Capacitive and Inductive; Encoders	**5**	**11**
5	**Stress- Strain Measurement and Strain Gauges:** Mechanical Strain gauges; Optical Strain Gauges; Rosette Gauges; Sensing Element Materials; Based on form of SG - Wire and Foil; Configuration - uniaxial strain, biaxial or multidirectional strain and special purpose gauges; Carrier materials - permanent and temporary; SG Adhesives; Lead Wire Systems; Protective coating; Bonded wire SG and bonding techniques - Types of bonded wire SG, bonding techniques and procedure for cementing; moisture proofing of SG; Instrumentation for SG - Wheatstone Bridge, Temperature compensation, self temperature compensating SG, instruments for static and dynamic strain measurements.	**5**	**11**
6	**Speed, Velocity, Acceleration and Vibration:** Definitions of Speed, Velocity, Acceleration and Vibration **Speed and Velocity** - Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Hand-Held Tachometers, Capacitor-type impulse tachometer, optical tachometer, encoder, stroboscopic tachometers, Translational Velocity Transducer, Mechanical Flyball Angular velocity sensor, Velocity Measurement as $\Delta x/\Delta t$ - Variable Reluctance proximity pickup, Hall Effect Proximity pickup, eddy current proximity pickup **Acceleration and Vibration** - Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Relative Acceleration Measurements, Seismic (Absolute) Acceleration Pickups (Accelerometers) - Voltage Divider Potentiometer, Eddy current Proximity sensor as Vibration Pickup, Mechanical Vibration Sensor.	**5**	**11**
7	**Measurement of Density and Viscosity:** **Density:** Definition of density, relative density and its units. Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Displacement and Float type Densitometers (For Liquid Density), Hydrometers, Hydrostatic Density meter, Ultrasonic and Sonic densitometers, Radiation Densitometers and Gas Densitometers **Viscosity:** Absolute (or dynamic viscosity), consistency,other terms related	**5**	**11**

	to absolute (dynamic) viscosity, other important terms. Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Capillary (Laboratory and Industrial), Efflux Cup, Falling Ball, Float (Rotameter type), Vibrating Reed,Oscillating Type Viscometers and Plastometers. Probe type, Blade type,Float type, Rotating type, Optical type, Level and Flow Bridge Consistency Meter. Selection of Viscometers and Consistency Meters.		
8	**Acoustic Measurement:** Characteristics of Sound; Sound Pressure; Power and Intensity Levels; Loudness; Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications Typical Sound Measuring Systems - Sound Level Meter, Sound Intensity Measurement; Microphones - Condenser or Capacitive type, Electret Microphone, Piezo-electric Microphone and Electrodynamic type microphone; Sonar, Surface Acoustic Wave (SAW)Sensor, Acoustic Intensity Measurement	**5**	**11**
9	**Development in Sensor Technology:** Semiconductor Sensor - Basics, Materials and Techniques; Smart Sensors - Definition and Configuration; Microsensors - Microsize Microphone, Inertial Sensor, Hall effect Sensor and Polymer Sensor	**2**	**5**
	Total	**45**	**100**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**15**	**20**	**10**	**10**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Industrial Measurement - II* directly contributes to

Reference Book:

1. K. Krishnaswamy and S. Vijayachitra, Industrial Instrumentation, 2nd edition, New Age international Publication.
2. B. C. Nakra and K. K. Chaudhary, Instrumentation Measurement and Analysis, 3rd Edition, Tata McGraw Hill

SDG 3	**Good Health and Well Being**
SDG 9	**Industry, Innovation and Infrastructure**
SDG 11	**Sustainable Cities and Communities**
SDG 12	**Responsible Consumption and Production**

3. C. S. Rangan, G. R. Sarma, V. S. V. Mani, Instrumentation Devices and Systems, 2nd Edition, Tata McGraw Hill
4. D. Patranabis, Principles of Industrial Instrumentation, 2nd Edition, Tata McGraw Hill
5. D. V. S. Murthy, Transducers and Instrumentation, 2nd Edition, PHI Publisher

List of Experiments:

- To study & perform linear and rotary displacement measurement using potentiometer
- To measure displacement using LVDT and plot the characteristics.
- To measure force using Strain Gauge and plot its characteristics.
- To measure speed using a Tachometer.
- To characterize the Proximity sensors (inductive) and study its behavior.
- To measure velocity using stroboscope
- To measure sound using a microphone.
- To measure humidity using a psychrometer.
- To measure velocity using a fly ball tachometer.
- To measure density using Hydrometer
- To measure viscosity using Viscometers

Major Equipment:

- LVDT
- Potentiometer
- Rheostat
- Strain Gauge
- Tachometer
- Proximity Sensors
- Stroboscope
- Psychrometer
- Fly ball tachometer
- Hydrometer
- Viscometer

List of learning resources/website:

1. Virtual Labs by IITs (Government of India Initiative) (https://vlab.co.in/)
2. NPTEL / SWAYAM (https://nptel.ac.in/)
3. DTE Common Lab manual

Activities suggested under self-learning:

Sr. No.	PBL Category	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry / Research Laboratory Visit	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on the report submitted. Report should contain observations and calculations Based on industry/lab data.
2.	Video Based Learning	Technical Video based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5h Report preparation=5h Total= 10h	Report/presentation based on the video learning outcomes.
3.		Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment At the end of course. Based on the certificate produced.
4.		Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted
5.	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical Based assignment is preferable.	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.
6.		Problem solving/Coding using C, C++, Python, SCILAB,	5 small coding-based assignments of 2h each. Total =	Based on the coding solution submitted.

		MATLAB,MS-EXCEL or any Other relevant software	10h	
7	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total=10h	Based on the depth of the Solution submitted.
8	Research Paper Review / Analysis	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters
9.	Poster/ Chart/ Power poin presentation	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills
10	Micro Project	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation
11	Group Discussion / Quiz / Simulation	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
12		Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation=5h Total= 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Other	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Industrial Measurement II* incorporates;
   - Mini Project – 10 Marks
   - Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Instrumentation and Control / Electronics and Instrumentation
Subject Code: BE05000051
Subject Name: Power Electronics Devices and Drives

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	1. Basic Electrical Engineering, 2. Basic Electronics Engineering, 3. Basics of Control Systems
Rationale:	This course provides a comprehensive understanding of power semiconductor devices (SCR, IGBT, MOSFET) and their applications in controlling electric motors for industrial automation. It covers device characteristics, power converters (AC-DC, DC-DC, DC-AC, AC-AC), and their integration into complete DC and AC drive systems, bridging the gap between device-level knowledge and system-level drive applications.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Understand the construction, operating principle, characteristics, and protection requirements of various power semiconductor devices like SCR, IGBT, and MOSFET.	20%
CO-2	Apply the knowledge of power electronic converters to analyze the performance of single-phase and three-phase AC-DC, DC-DC, and DC-AC converters and single-phase AC-AC voltage controllers.	34%
CO-3	Apply control strategies for DC motor drives using converter-fed and chopper-fed methods, and for AC motor drives using stator voltage control and V/f control.	22%
CO-4	Analyze the performance of power electronic converters and drive systems for various industrial load conditions.	22%
CO-5	Analyze suitable power converters and drive schemes for specific industrial applications to achieve desired performance.	12%

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Content:

Sr. No.	Content	Total Hrs	% of Weightage
1	**Power Semiconductor Devices:** Introduction to Power Electronics, Need for power semiconductor devices. Silicon Controlled Rectifier (SCR): Structure, V-I characteristics, Two-transistor analogy, Turn-on and Turn-off methods, Gate triggering circuits, Ratings and protection (dv/dt, di/dt, overvoltage, overcurrent, snubber circuits), Series and parallel operation. Power Transistors: Power BJT, Power MOSFET - structure, working, characteristics. Insulated Gate Bipolar Transistor (IGBT): Structure, working principle, characteristics, latch-up, and applications. Other Devices: Introduction to GTO, TRIAC, DIAC, and their basic operating principles. Recent trends in power devices (e.g., SiC and GaN devices)	9	20
2	**AC to DC Converters (Phase-Controlled Rectifiers):** Principle of phase control. Single-phase half-wave and full-wave controlled rectifiers with R, RL, and RLE loads. Effect of freewheeling diode. Performance parameters of rectifiers. Single-phase fully-controlled and half-controlled bridge converters. Three-phase controlled rectifiers: three-pulse and six-pulse bridge converters with R load. Applications of rectifiers in drives and HVDC. Generation of firing pulses for converters.	8	18
3	**DC to DC Converters (Choppers):** Principle of step-down and step-up choppers. Control strategies (PWM and FM). Types of choppers: First quadrant, second quadrant, two-quadrant, and four-quadrant choppers (Type A, B, C, D, and E) with load. Steady-state analysis of buck and boost converters. Introduction to isolated converters: flyback and forward converters. Applications of choppers in SMPS and DC drives.	7	16
4	**DC to AC Converters (Inverters) and AC to AC Converters: Inverters**: Principle of operation. Single-phase half-bridge and full-bridge inverters with R load. Three-phase bridge inverters (180° conduction modes) with R load. Voltage control techniques: PWM techniques (single-pulse). **AC to AC Converters:** Principle of on-off control and phase control. Single-phase AC voltage controller with R load. Introduction to cycloconverters: single-phase to single-phase step-up and step-down cycloconverters.	11	24
5	**Electric Drives:** Fundamentals of Electric Drives: Basic block diagram, components, and classification of electric drives. Four-quadrant operation of drives. Joint speed-torque characteristics of motors and loads. **DC Drives:** Single-phase and three-phase converter-fed DC motor drives for speed control (continuous conduction mode). Chopper-fed DC motor drives for speed control (motoring and braking). **AC Drives**: Speed control of induction motors: Stator voltage control using AC voltage regulators, V/f control using inverters. Selection of drives for industrial	10	22

	applications (pumps, conveyors, etc.).		
	TOTAL	**45**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**15**	**20**	**10**	**10**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Power Electronics Devices and Drives* directly contributes to

SDG 7	**Affordable and Clean Energy**
SDG 8	**Decent Work and Economic Growth**
SDG 9	**Industry, Innovation and Infrastructure**
SDG 11	**Sustainable Cities and Communities**
SDG 12	**Responsible Consumption and Production**
SDG 13	**Climate Action**

Reference Books:

1. Rashid, M. H. "Power Electronics: Circuits, Devices, and Applications." 4th Edition, Pearson Education.
2. Bimbhra, P. S. "Power Electronics." 4th Edition, Khanna Publishers.
3. Mohan, N., Undeland, T. M., & Robbins, W. P. "Power Electronics: Converters, Applications, and Design." 3rd Edition, John Wiley & Sons.
4. Sen, P. C. "Power Electronics." Tata McGraw-Hill.
5. Dubey, G. K. "Fundamentals of Electrical Drives." 2nd Edition, Narosa Publishing House.
6. El-Sharkawi, M. A. "Fundamentals of Electric Drives." Brooks/Cole Publishing.
7. Singh, M. D., & Khanchandani, K. B. "Power Electronics." 2nd Edition, Tata McGraw-Hill.

List of Experiments:

1. Study/Perform and plot the V-I characteristics of an SCR and TRIAC.
2. Study/Perform and plot the transfer and output characteristics of an IGBT and Power MOSFET.
3. Implement a firing circuit for an SCR using UJT (R, R-C) and observe the waveform.
4. Study/Perform and analyze the performance of a single-phase half-wave-controlled rectifier with R and RL load.
5. Study/Perform and analyze the performance of a single-phase fully-controlled bridge rectifier with R and RL load.
6. Study/Perform and analyze the performance of a step-down (Buck) chopper (Either perform a hardware experiment or simulate using appropriate software)
7. Study/Operate a four-quadrant chopper (Type E) for DC motor control (Either perform a hardware experiment or simulate using appropriate software)
8. Study/Perform the operation and output waveform of a single-phase PWM inverter (Either perform a hardware experiment or simulate using appropriate software)
9. Study/Perform the speed control of a DC shunt motor using a single-phase fully-controlled rectifier (Either perform a hardware experiment or simulate using appropriate software)
10. Study/Perform the speed control of a three-phase induction motor using V/f controlled PWM inverter (Either perform a hardware experiment or simulate using appropriate software)
11. Simulate a three-phase bridge inverter with 180° conduction mode using simulation software (e.g., MATLAB/Simulink, PSIM, or SCILAB)
12. Prepare a case study on the application of power electronic drives in any industry (e.g., textile, rolling mill, cement plant).

Major Equipment:

1. Power Electronics Trainer Kits (SCR, MOSFET, IGBT based)
2. Single-Phase and Three-Phase Controlled Rectifier Trainer Kits
3. DC–DC Chopper Trainer Kit (Buck/Boost Converter)
4. Single-Phase and Three-Phase PWM Inverter Trainer Kit
5. AC Voltage Controller and Cycloconverter Trainer Kit
6. DC Motor Drive Setup (Converter-fed and Chopper-fed)
7. AC Motor Drive Setup (V/f Control using Inverter)
8. Digital Storage Oscilloscope (DSO) – Minimum 100 MHz
9. Function Generator / Pulse Generator for Triggering Circuits
10. Power Analyzer / Digital Multimeter
11. Isolation Transformer and Power Supply Units

12. MATLAB/Simulink Software with Simscape Electrical Toolbox

List of Open Source Software

1. Scilab (https://www.scilab.org/) – Open-source alternative for simulation of power electronic circuits
2. OpenModelica (https://openmodelica.org/) – Modeling and simulation of power systems and converters
3. PSIM (Student/Free Version) – Simulation of power electronic converters
4. LTspice (https://www.analog.com/ltspice/) – Circuit simulation tool for power electronics
5. KiCad (https://www.kicad.org/) – Open-source PCB design tool

List of learning website:

1. NPTEL / SWAYAM (https://nptel.ac.in/) – Courses on Power Electronics and Electric Drives
2. MIT OpenCourseWare (https://ocw.mit.edu/) – Advanced resources on power electronics and control
3. Virtual Labs by IITs (https://vlab.co.in/) – Simulation-based experiments for power electronics
4. All About Circuits (https://www.allaboutcircuits.com/) – Tutorials on electronic devices and circuits
5. Electronics Tutorials (https://www.electronics-tutorials.ws/) – Concepts of converters and semiconductor devices
6. Reputed Research Journals (IEEE, Springer, Elsevier) – Latest advancements in power electronics

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL Category	Name of the Activity	No. of Hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Visit to industry (power electronics/drives/automation plant) to study converters and drive systems	Visit = 5 hrs, Report = 5 hrs Total = 10 hrs	Based on report with observations, system analysis and calculations
2	Video Based Learning	Technical video learning on converters, inverters, drives (NPTEL/MOOC)	Video = 5 hrs, Report = 5 hrs Total = 10 hrs	Report/presentation based on learning outcomes
3	Self-learning Online Course	Online course on Power Electronics / Electric Drives	Minimum 10 hrs	Based on certification and assessment
4	Annotated Video Explanation	Explanation of topics like PWM, rectifiers, choppers with recorded video	10 hrs	Clarity, technical accuracy, presentation
5	Assignment / Technical	Numerical assignments on rectifiers, choppers, inverters, drives	5 assignments × 2 hrs = 10	Based on correctness and understanding

	Writing		hrs	
6	Blog / Technical Article Writing	Article on EV drives, renewable energy converters, smart grids	10 hrs	Originality, technical depth
7	Complex Problem Solving / Mini Project	Design problems like DC drive system, inverter-based system, SMPS design	Max 2 problems = 15 hrs	Based on solution depth and design approach
8	Research Paper Review / Analysis	Review papers on power converters, EV drives, HVDC systems	5 papers = 20 hrs	Summary, technical analysis
9	Poster / PPT Presentation	Topics like PWM techniques, converter comparison, electric drives	6 hrs	Presentation quality and technical content
10	Micro Project	Develop small project like DC motor speed control / inverter system	10 hrs	Working model and implementation
11	Group Discussion / Quiz	Discussion on EV technology, Industry 4.0, renewable energy	1 hr each	Participation and technical depth
12	Online Technical Quiz / Simulation	Quiz on converters, devices, drives	Total = 10 hrs	Quiz performance
13	Case Study Analysis / Seminar	Case study on industrial drives (textile, cement, EV applications)	Study = 5 hrs, Report = 5 hrs Total = 10 hrs	Depth of analysis and real-world relevance
14	Other	Patent search in power electronics and electric drives	10 hrs	Innovation gap identification

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Power Electronics Devices and Drives* incorporates;

- Mini Project – 10 Marks
- Micro Project and – 5 Marks
- Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Instrumentation and Control / Electronics and Instrumentation
Subject Code : BE05000061
Subject Name : Biomedical Instrumentation

WEF Academic Year:	2024-2025
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	Basic knowledge of Electronic instruments and measurement systems, Sensors and transducers, Signals and systems, Basic human physiology
Rationale:	Biomedical Instrumentation Integrates Electronics, Instrumentation, and medical science to develop devices used for monitoring, diagnosis, and treatment of patients. This course introduces the principles of physiological measurement, bioelectric signal acquisition, diagnostic instruments, therapeutic devices, and medical imaging systems. It also emphasizes patient safety and electrical safety standards in medical equipment.

Course Outcome:

Sr. No	Course Outcomes	Marks% weightage
CO-1	Explain the fundamentals of biomedical instrumentation and physiological measurement systems.	20
CO-2	Understand the origin of bioelectric signals and the role of electrodes in biomedical measurements.	20
CO-3	Analyze the working principles and design of bioelectric amplifiers.	20
CO-4	Describe the working of diagnostic instruments such as ECG, EEG and blood pressure monitors.	30
CO-5	Explain therapeutic instruments, imaging systems and safety considerations in biomedical instrumentation.	10

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause***

9.4 of NBA manual.

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Basic Human Anatomy for Instrumentation:** Overview of cardiovascular system, nervous system, and muscular system; relevance of these systems in biomedical signal generation (ECG, EEG, EMG). **Fundamentals of Medical Instrumentation:** Introduction to Biomedical Instrumentation, Role of instrumentation in healthcare, Components of a generalized biomedical instrumentation system, Sources of physiological signals, Medical measurement constraints, Classification of biomedical instruments, Transducers used in biomedical applications, Problems associated with biological measurements.	**8**	**17**
2	**Bioelectric Signals and Electrodes:** Origin of bioelectric potentials, Resting potential and action potential, Types of bioelectric signals: ECG, EEG, EMG, Ionic conduction in biological tissues, Electrode–electrolyte interface, Half-cell potential, Polarization effects, Types of electrodes: Surface electrodes, Needle electrodes, Microelectrodes, Electrode impedance, Motion artifacts and noise in electrodes	**8**	**17**
3	**Bioelectric Amplifiers:** Characteristics of bioelectric signals, Requirements of bioelectric amplifiers, Differential amplifier for biomedical signals, Instrumentation amplifiers, Common Mode Rejection Ratio (CMRR), Noise sources in biomedical instrumentation, Interference reduction techniques, Isolation amplifiers, Patient protection techniques, Grounding and shielding methods	**6**	**13**
4	**Diagnostic Instruments** **Electrocardiograph (ECG):** Electrical activity of the heart, Lead configurations (standard limb leads, augmented leads, chest leads), ECG machine block diagram and working, ECG Telemetry **ECG waveform: Interpretation & Analysis:** Normal waveform parameters, heart rate calculation methods, rhythm and basic arrhythmia identification, ST-segment ischemia assessment, and fundamentals of automated ECG interpretation, **Electroencephalograph (EEG):** Electrical activity of the brain, EEG waveforms (alpha, beta, theta, delta), EEG electrode placement system, EEG recording system **Electromyograph (EMG):** Basic Principle, Block diagram of EMG machine. **Blood Pressure Measurement:** Direct blood pressure measurement, Indirect blood pressure measurement, Sphygmomanometer, Electronic	**9**	**20**

	blood pressure monitors		
5	**Therapeutic and Imaging Instruments** ***Therapeutic Equipment*** **Cardiac pacemaker:** Types of pacemakers, Working principle **Defibrillator:** Types of defibrillators, Energy delivery system **Ventilator:** Principles of mechanical ventilation, Modes of ventilation ***Medical Imaging Systems*** **X-ray imaging:** X-ray generation, X-ray imaging system components **Computed Tomography (CT Scan):** Basic principle, Image reconstruction concept **Medical Ultrasonography:** Basic principle, Ultrasound transducer, Scan modes and scanning system	**8**	**17**
6	**Safety in Biomedical Instrumentation:** Electrical safety in medical equipment, Macroshock and microshock hazards, Leakage currents, Patient isolation techniques, Grounding methods in hospitals, Safety standards for medical instruments, Testing procedures for biomedical equipment	**4**	**9**
7	**Recent Advances in Biomedical Instrumentation:** Wearable devices (ECG, PPG, glucose, RPM (Remote Patient Monitoring)), AI/IoMT (Internet of Medical Things) for diagnostics, portable imaging, closed-loop therapies, and regulatory challenges.	**2**	**4**
	Total	**45**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	**30**	**15**	**20**	**5**	**5**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Biomedical Instrumentation* directly contributes to

SDG 3	**Good Health and Well-Being**
SDG 4	**Quality Education**

SDG 9	**Industry, Innovation and Infrastructure**
SDG 12	**Responsible Consumption and Production**

Reference Book:

1. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata – McGraw Hill Publication
2. Introduction to Biomedical Equipment Technology by Joseph J. Carr and John M. Brown, Pearson Publication
3. Medical Instrumentation- Application and Design by John. G. Webster, John Wiley & Sons,
4. Biomedical Instrumentation and Measurements by Leslie Cromwell, Fred J. Weibell & Erich A. Pfeiffer, PHI publication
5. Wearable Sensors and IoT in Healthcare by Subhas Chandra Mukhopadhyay, Springer (or recent IEEE/Elsevier publications on AI in biomedical instrumentation)

List of Experiments:

1. Study of various physiological systems of the human body.
2. Study of ECG signal acquisition system & Simulation of ECG signal processing using VLAB.
3. Study and demonstration of different types of bio-potential electrodes.
4. Study of Electroencephalography (EEG) and observe the operation of EEG machine.
5. Study Blood pressure (BP) measurement techniques and observe the working of automatic BP machine.
6. Study & implementation of instrumentation amplifier used in biomedical signals
7. Study of pacemaker using simulation/video. Also observe the operation of external pacemaker.
8. Study of defibrillator using simulation/video.
9. Study of X-ray and CT scan imaging systems
10. Study of the importance of electrical safety in hospitals.

Major Equipment:

1. ECG Simulator
2. EMG Simulator
3. EEG Simulator
4. Blood Pressure Machine (Digital or Sphygmomanometer)
5. Pacemaker
6. Defibrillator
7. X-Ray Model

8. CT Scan Model
9. Various Bio-potential Electrodes

List of learning website/ resources:

1. NPTEL / SWAYAM (https://nptel.ac.in/)
2. Virtual Labs by IITs (https://vlab.co.in/)
3. DTE Common Lab manual

Activities suggested under self-learning:

Sr. No.	PBL Category	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry / Research Laboratory Visit	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on the report submitted. Report should contain observations and calculations Based on industry/lab data.
2.	Video Based Learning	Technical Video based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5h Report preparation=5 h Total= 10h	Report/presentation based on the video learning outcomes.
3.		Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment At the end of course. Based on the certificate produced.
4.		Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted

Note:

5.	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical Based assignment is preferable.	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.
6.		Problem solving/Coding using C, C++, Python, SCILAB, MATLAB,MS-EXCEL or any Other relevant software	5 small coding-based assignments of 2h each. Total = 10h	Based on the coding solution submitted.
7	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total= 10h	Based on the depth of the Solution submitted.
8	Research Paper Review / Analysis	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters
9.	Poster/ Chart/ Power poin presentation	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills
10	Micro Project	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation
11	Group Discussion / Quiz / Simulation	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
12		Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.

13.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation=5 h Total= 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Other	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Biomedical Instrumentation* incorporates

- Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Instrumentation and Control / Electronics and Instrumentation
Subject Code : BE05000081
Subject Name : Machine Learning for Industrial Automation

WEF Academic Year:	2024 -2025
Semester:	5
Category of the Course:	Professional Elective Course -02

Prerequisite:	Basic Proficiency in a Programming language, preferably **Python**, and basics of algorithms. Core Engineering and Automation Basics
Rationale:	The Machine Learning syllabus in Industrial Automation is aligned with Industry 4.0 and Smart Manufacturing concepts, where intelligent and data-driven systems are widely used in modern industries. It helps students understand applications such as predictive maintenance, fault detection, quality control, and process optimization. The course also enables effective handling and analysis of manufacturing data generated through sensors and automated systems. This knowledge enhances students' ability to develop smart industrial solutions and meet current industry requirements.

Course Outcome:

Sr. No	Course Outcomes	Marks% weightage
CO-1	Analyze and prepare data for machine learning models.	25
CO-2	Implement probability-based models and supervised learning algorithms.	20
CO-3	Design solutions using unsupervised and reinforcement learning techniques.	25
CO-4	Construct basic Artificial Neural Networks and compare advanced learning algorithms.	20
CO-5	Develop end-to-end machine learning pipelines and evaluate Generative AI applications.	10

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction to Machine Learning:** What is Human Learning?, Types of Human Learning, What is Machine Learning?, Types of Machine Learning, Need for Machine Learning, Application of Machine Learning, Languages and Tools in Machine Learning, Issues in Machine Learning, Problems not to be solved using Machine Learning	**2**	**4**
2	**Basic of Matrix Operations, Probability and Bayesian Concept Learning:** **Matrix Operations:** Addition, Multiplication, Subtraction, Division, transpose, and inverse, Types of Matrices **Probability:** Importance of Statistical tools in Machine Learning; Concept of Probability - Frequentist and Bayesian Interpretation; Random Variable - Discrete and Continuous; Common Discrete Distributions - Bernoulli, Binomial, Multinomial and Multinoulli and Poisson's distribution; Common Continuous Distributions - Uniform, Gaussian (Normal) and Laplace Distribution; Multiple Random Variables - Bivariate random variables, Joint distribution functions, joint probability mass functions, joint probability density functions, conditional distributions and covariance and correlation, central limit theorem; Sampling distributions - Sampling with and without replacement, mean and variance of sample; hypothesis Testing and Monte Carlo Approximation **Bayesian Concept Learning:** Importance; Bayes' theorem - Prior, Posterior and Likelihood; Bayes' Theorem and Concept Learning - Brute-force Bayesian algorithm, concept of consistent learners, bayes optimal classifier, applications of naive bayes classifier, handling continuous numeric features in naive bayes classifier; Bayesian belief Network - Independence and conditional independence, its use in machine learning.	**4**	**9**
3	**Preparing to Model:** Machine Learning Activities; Basic types of data in Machine Learning; Exploring structure of Data - Exploring numerical data, plotting and exploring numerical data, exploring categorical data, exploring relationship between variables; Data Quality and Remediation; Data Pre-Processing - Dimensionality Reduction and Feature Subset Selection.	**2**	**4**
4	**Modelling and Evaluation:** Selecting a Model - Predictive or descriptive; Training a model (for	**2**	**4**

	supervised learning) - Holdout Method, k-fold cross validation method, bootstrap sampling, lazy vs eager learner; Model Representation and Interpretability - underfitting, overfitting and bias variance tradeoff; Evaluating Performance of a model - Supervised learning (Classification and Regression) and Unsupervised learning (Clustering); Improving performance of a model.		
5	**Basics of Feature Engineering:** What is a feature and feature engineering?; Feature Transformation - Construction and Extraction; Feature Subset Selection - Issues in high dimensional data, key drivers of feature selection - feature relevance and redundancy, measures of feature relevance and redundancy, Overall feature selection process, feature selection approaches	**2**	**4**
6	**Supervised Learning** **Regression:** Examples of Regression; Common Regression Algorithms: Simple Linear Regression, Multiple Linear Regression, Assumptions in Regression Analysis, Problems in Regression Analysis, Improving accuracy of Linear Regression Model, Logically weighted Linear Regression, Polynomial Regression Model, Logistic Regression,Multiclass Logistic Regression, Maximum Likelihood Estimation. **Classification:** Introduction and example of supervised learning, classification model, classification learning steps, Common classification algorithms - k-Nearest Neighbour(kNN), Decision Tree, Random Forest Model, Support Vector Machine.	**7**	**16**
7	**Unsupervised Learning:** Application of unsupervised learning; Clustering - Clustering as a machine learning task, different types of clustering techniques, partitioning methods, K-Mediods: a representative object based technique, Hierarchical Clustering, Density based methods - DBSCAN; Finding pattern using association rule - Definition of common terms, Association rule, Apriori algorithm for association rule learning, build the apriori principle rules	**7**	**16**
8	**Reinforcement Learning:** What is Reinforcement Learning?; Elements of Reinforcement Learning - Agent, Environment, State, Policy, Reward, Value function, Model, Introduction to Farama Foundations “The Frozen Lake RL Environment; Principles; Reinforced Learning Algorithm - Dynamic Programming, Monte Carlo Methods, Temporal Difference Learning (TD); Sample Python Implementation of Q-Learning,Applications of RL	**4**	**9**
9	**Basics of Neural Network:** Understanding the Biological Neuron; Exploring Artificial Neuron; Types	**4**	**9**

	of Activation Functions - Identity, Threshold/Step, ReLU, Sigmoid and Hyperbolic Tangent functions; Architectures of Neural Networks - Single layer feed forward network, Multilayer feed forward layer, Competitive Network and Recurrent Network; Learning process in ANN - Number of layers, Direction of Signal Flow, Number of nodes in layers, Weight of interconnection between neurons; Early implementations of ANN - McCulloch Pitts Model, Rosenblatt's perceptron, ADALINE Network Model; Back Propagation, Deep Learning		
10	**Generative AI and LLMs:** Introduction to NLP; Generative Models - Foundational architectures; LLMs: Few Popular LLMs, Challenges and Risks with LLMs, Hallucinations; How is ChatGPT Trained?; Applications of Generative AI; Prompt Engineering - Types of Prompts, Applications, Integrating LLMS into Python using Langchain, Pair Programming powered by Prompt Engineering, Best Practices in Prompt Engineering.	**5**	**11**
11	**Case Studies and Implementations:** Detection of Iris Flower Species, Handwritten Digit Detection Sentiment based clustering of Text Data, Predictive Maintenance: Trends, Challenges, and Future Directions	**6**	**14**
	Total	**45**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**30**	**20**	**20**	**10**	**10**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Machine Learning* directly contributes to

SDG 4	**Quality Education**
SDG 8	**Decent Work and Economic Growth**

SDG 9	**Industry, Innovation and Infrastructure**
SDG 12	**Responsible Consumption and Production**

Reference Book:

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, "Machine Learning" 2nd Edition, Pearson Publication
2. Anuradha Srinivasaraghavan and Vincy Joseph, "Machine Learning", 1st Edition, Wiley Publication
3. Christos Tsallis, Panagiotis Papageorgas, Dimitrios Piromalis and Radu Adrian Munteanu, "Application-Wise Review of Machine Learning-Based Predictive Maintenance: Trends, Challenges, and Future Directions", *MDPI Applied Sciences Journal*, 2024.

List of Experiments:

1. To learn the basics of Python.
2. To implement linear regression using least square method/normal equation with single variable
3. To implement linear regression using least square method/normal equation with multiple variable
4. Implementation of gradient descent algorithm for single variable using MATLAB Software
5. Implementation of gradient descent algorithm for multiple variables using MATLAB Software
6. Implementation of logistic regression for binary classification
7. Implementation of Single layer ANN
8. Implementation of Normal Equation using MATLAB Software
9. To study neural network as sine wave function approximator
10. To study Neural Network based controller design.
11. Write a program using SVM on IRIS dataset and carry out classification.
12. To implement K-Means clustering on Iris dataset to group flowers based on features.
13. To apply dimensionality reduction on a digit dataset.

List of Open Source Software

1. Anaconda (Jupyter)
2. Google Colab

3. Python
4. R Language

List of learning website/ resources:

1. NPTEL / SWAYAM (https://nptel.ac.in/)
2. Virtual Labs by IITs (https://vlab.co.in/)
3. DTE Common Lab manual

Activities suggested under self-learning:

Sr. No.	PBL Category	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry / Research Laboratory Visit	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on the report submitted. Report should contain observations and calculations Based on industry/lab data.
2.	Video Based Learning	Technical Video based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5h Report preparation=5h Total= 10h	Report/presentation based on the video learning outcomes.
3.		Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment At the end of course. Based on the certificate produced.
4.		Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted
5.	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical Based assignment is	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.

		preferable.		
6.		Problem solving/Coding using C, C++, Python, SCILAB, MATLAB,MS-EXCEL or any Other relevant software	5 small coding-based assignments of 2h each. Total = 10h	Based on the coding solution submitted.
7	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total= 10h	Based on the depth of the Solution submitted.
8	Research Paper Review / Analysis	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters
9.	Poster/ Chart/ Power poin presentation	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills
10	Micro Project	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation
11	Group Discussion / Quiz / Simulation	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
12		Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report	Based on in-depth study, technical depth, data collected, fact

			preparation=5h Total= 10h	finding, etc.
14.	Other	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Machine Learning for Industrial Automation* incorporates;
   - Mini Project – 10 Marks
   - Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Instrumentation and Control / Electronics and Instrumentation
Subject Code : BE050000101
Subject Name : Instrumentation Project Management

WEF Academic Year:	2024-2025
Semester:	5
Category of the Course:	Professional Elective Course - 2

Prerequisite:	Sensor/ transducer, field transmitters, converters, final control element, basic instrumentation symbols, process control modes and techniques, Computer based control system architecture
Rationale:	For an Instrumentation and Control Engineer it is very important to know the kind of standard documents available in manufacturing processes along with necessary design, test and calibration procedures. This subject will help students to understand the project procedures and various stages of the project like planning, estimation, designing, installation, testing, calibration and commissioning of instruments and systems. The last topic of the syllabus will introduce students to the quality manufacturing process.

Course Outcome:

Sr. No	Course Outcomes	Marks% weightage
CO-1	Understand the importance of project management from industrial perspective	20
CO-2	Estimate cost for implementing various industrial projects	15
CO-3	Apply various engineering design criteria for optimized project management	25
CO-4	Evaluate and select various sensors and control valve for successful realization of specific project	15
CO-5	Follow standard practices as well as procedures for construction and startup of project	25

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	30	0	15	90	03	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction to project management** Definition of project purpose - Scope, time, quality and organization structure. Basic and detailed engineering: Degree of automation, Project S curves, manpower considerations, inter-department and inter-organization interactions, Multi agency interaction. Types of projects and types of contracts e.g. EPC, BOOT etc. Risk Management in Instrumentation Projects, EPCM Contracting model	**5**	**10**
2	**Project management** functions Controlling, directing, project authority, responsibility, accountability, interpersonal influences and standard communication formats, project reviews. project planning and scheduling, life project engineering and management cycle phases, the statement of work (SOW), projects specifications, bar charts, milestones, schedules, work breakdown structures, cost breakdown structures and planning cycle. —Agile Learning, Risk Based Scheduling, PMIS, Stakeholder & communication.	**5**	**10**
3	**Project cost and estimation** Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software used in project management.	**5**	**10**
4	**Instrument Project Control** Project engineering documents and drawing: Process flow sheets, Mechanical flow sheets, Instrument index sheets, loop wiring diagram, panel drawings and specifications, plot plans, installation details, special drawings, purchase requisition, other documents. Information required: Process information, Instrument specifications and standards, Electrical specifications, bid documents, Project procedure, project schedule, Equipment Information, Vendor drawing Work coordination: Project manager, process engineer, equipment engineer, Electrical, purchasing and expediting and others Planning hints and Project check list. Document control System (EDMS), Engineering Documentation (C&E, Control Narratives, FBD, Ladder Logic). Loop-wise Detailing (AI, AO, DI, DO, Termination) Hook-up Diagrams & BOM FAT/SAT	**5**	**15**
5	**Engineering Design criteria** Pneumatic versus electronics system,	**10**	**25**

	Control centers, Future and spare capacity Specifications for various measurement and control groups: Flow, Pressure, Level, Temperature, Control valves, Control panels, Analytical instruments Transmission systems: Pneumatic & Electronic – Materials, Distribution, Terminations and Identification Process connections – Take-offs and Piping, Location of taps, Sealing instruments from process, Manifolds and gage valves Miscellaneous Design Criteria: Mounting instruments, Selections of units, charts, ranges; Instrument identification, Winterizing, Material of construction, Package equipment systems Electrical safety: NEC code, Purging and pressurization, Enclosures, Intrinsic safety, EPC Projects - Power Plant, Oil and Gas, Wastewater treatment, dairy and food, pharmaceuticals and chemical plants. Functional Safety (SIL, IEC 61511), LOPA, Process Safety Management (PSM) & MOC, Modern safety standards (OSHA, ISO 45001)		
6	**Construction and Start up Organizing:** Documents, schedule, cost control Ordering and Receiving equipment and Material: Purchase orders, Material status, storage Installing instrument systems: Procedures, Coordination, Good installation practices Calibration Testing: Process connections, Pneumatic lines, Electrical Loop checking: Flow transmitter , Temperature transmitter, Control valve, Miscellaneous checks Startup: Placing instruments in service, Tuning loop controls, evaluating process upsets and disturbances, Repairing or replacing defective equipment, special equipment, Construction Safety Practices (PTW, LOTO, confined space, work at height)	**10**	**20**
7	**Introduction to International quality systems** - ISO 9000 Quality management practices worldwide, certifying agencies. Quality, customers and ISO 9000 ISO 9000, IEI and Test standards and Calibration,	**5**	**10**
	Total	**45**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**30**	**20**	**20**	**10**	**10**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Instrumentation Project Management* directly contributes to

SDG 8	**Decent Work and Economic Growth**
SDG 9	**Industry, Innovation and Infrastructure**
SDG 12	**Responsible Consumption and Production**

Reference Book:

1. Applied Instrumentation in Process Industries by W.G. Andrew and H.B. Williams, Gulf Professional Publishing, 3rd ed. 2008, ISBN-13: 978-0872010475.
2. Project management: A systems approach to planning scheduling and controlling by Harlod Kerzner and Van Nostrand, John Wiley & Sons, 11th ed., 2013, ISBN: 978-1-118-02227-6.
3. Successful Instrumentation & Control Systems Design, by Michael D. Whitt, 2nd Edition, 2012, ISA, ISBN: 978-1-93600-745-5.
4. ISO- 9000 Concepts, Methods & Implementation by Tapan B. Bagchi, Wheeler pub., 1995. ISBN-81-85814-24-4
5. ISO- 9000 Guidelines for the chemical & process industries : By ASQC (American Society of Quality Control) , ISBN-13: 978-0873893527, www.asq.org Reference Books: Instrument Engineers Handbook: Process Control by Bela G Liptak, CRC Press, 3rd ed., 1995, ISBN 13: 978-0801982422.
6. Advanced Project Management: Best Practices on Implementation – Harold Kerzner
7. Project Management, Planning and Control – Albert Lester
8. Engineering Project Management – Neil G. Siegel
9. Project Management for Engineering, Business and Technology – John M. Nicholas

List of Tutorials:

1. Study of standards and symbols (ANSI / ISA Std.)
2. Study of specification sheets.
3. Development of Process & Instrument diagram of typical process
4. Development of Loop Wiring diagram.
5. Cable scheduling.
6. GA and mimic diagram of a control panel.
7. Development of Bar charts for certain project.
8. Prepare the cost estimation sheet for the project under consideration
9. Hands-on experience for engineering management software such as MS Project, Primavera, etc.
10. Designing of control valve for liquid/gas/vapor applications as per standard
11. Design of orifice plates for liquid/gas/vapor as per ISO 5167

12. Operating range calculation for transmitters considering different applications.
13. Preparation of Inspection Test Plan,
14. Usage of calibrating equipment for loop checking,
15. RTD, thermocouple simulation using simulators,
16. 4 -20 mA current loop simulators for loop checking
17. Dry and wet loop checking,
18. Usage of various instruments like calibrators, DW testers, etc
19. Understanding impulse tubing, Laying, bending, supporting and connection of impulse tubing,
20. Understanding impulse tube fittings.

List of learning website/ resources:

1. Functional Safety (SIL, IEC 61511)
   - IEC 61511 Standard (Free Download) – Bureau of Indian Standards publication available via Internet Archive Archive
   - Free Guide to IEC 61511 – eFunctionalSafety overview with lifecycle and SIL concepts eFunctionalSafety
   - Abhisam Quick Guide to Functional Safety & SIL – Free PDF for engineers Abhisam
2. LOPA (Layer of Protection Analysis)
   - While no single open-source textbook exists, Open Textbook Library and LibreTexts host risk analysis and safety engineering materials that include LOPA methodology Center for Open Education LibreTexts
   - □ Process Safety Management (PSM) & MOC
   - OSHAcademy Course 736 Study Guide: Introduction to PSM – Free PDF covering OSHA's 14 elements Archive
   - OSHA 3132 Process Safety Management Booklet – Public domain, practical compliance guide Occupational Safety and Health Administration
   - AIChE CCPS Key Principles of MOC (2024) – Guideline for Management of Change AIChE
3. Modern Safety Standards (OSHA, ISO 45001)
   - ISO 45001 Overview – International OH&S management system standard ISO - International Organization for Standardization
   - OSHA Publications – Free digital safety manuals and compliance guides Occupational Safety and Health Administration
4. Construction Safety Practices (PTW, LOTO, Confined Space, Work at Height)
   - Delhi Labour Department Safety Manual for Construction Workers – Covers PTW, confined space, work at height labour.delhi.gov.in
   - HSE Permit to Work Systems Guide – UK HSE free resource HSE
5. Document Control Systems (EDMS)

- OpenDocMan, Alfresco Community Edition, LogicalDOC – Leading open-source EDMS platforms The Digital Project Manager formkiq.com
- Engineering Documentation (C&E, Narratives, FBD, Ladder Logic)
- PLC Programming for Beginners (Free Guide) – Ladder logic examples and exercises electrical-world.com publicworks.jacksonms.gov
- InstTools Free Instrumentation Books – Includes tutorials on C&E diagrams and narratives Inst Tools

6. Loop-wise Detailing (AI, AO, DI, DO, Termination, Hook-up, BOM)
   - InstTools Wiring Diagrams of PLC/DCS Systems – Free resource for AI, AO, DI, DO wiring Inst Tools
   - Electrical Volt Wiring Diagrams – Detailed open-source guide Electrical Volt
7. FAT/SAT
   - Lessons in Industrial Instrumentation (Kuphaldt, CC License) – Covers FAT/SAT fundamentals The Public's Library and Digital Archive
8. Agile Learning, Risk-Based Scheduling, PMIS
   - Agile Practice Guide (PMI, free via GitHub Pages) cpske.github.io
   - InfoBooks Free Agile Methodology PDFs – Scrum, Kanban, XP, Lean InfoBooks.org
   - PMI Practice Standard for Scheduling – Free for PMI members Project Management Institute
9. Stakeholder & Communication
   - Open Textbook Library – Project Management (Adrienne Watt) – Includes stakeholder and communication planning Center for Open Education
10. Risk Management in Instrumentation Projects
    - PMBOK Guide (PMI) – Free foundational resource for risk management Project Management Institute
    - OpenStax Technology Texts – Free peer-reviewed engineering and risk-related materials OpenStax
11. EPCM Contracting Model
    - PwC EPCM Delivery Models (2024) – Free industry guide PwC
    - IChemE Engineering Contracts & Model Agreements – International model forms Institution of Chemical Engineers - IChemE
12. NPTEL / SWAYAM (https://nptel.ac.in/)
13. Virtual Labs by IITs (https://vlab.co.in/)
14. DTE Common Lab manual
15. ISA Website (http://www.isa.org)
16. IDC Technologies (http://www.idc-online.com)
17. MIT Open Course ware (https://ocw.mit.edu/ (engineering fundamentals))

Activities suggested under self-learning:

Sr. No.	PBL Category	Name of the activity	No. of hours per activity	Evaluation Criteria

1.	Industry / Research Laboratory Visit	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on the report submitted. Report should contain observations and calculations Based on industry/lab data.
2.	Video Based Learning	Technical Video based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5h Report preparation=5h Total= 10h	Report/presentation based on the video learning outcomes.
3.		Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment At the end of course. Based on the certificate produced.
4.		Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted
5.	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical Based assignment is preferable.	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.
6.		Problem solving/Coding using C, C++, Python, SCILAB, MATLAB,MS-EXCEL or any Other relevant software	5 small coding-based assignments of 2h each. Total = 10h	Based on the coding solution submitted.
7	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Complex problem solving	Maximum 2 problems. Study of the problem and	Based on the depth of the Solution submitted.

			solution finding, Total= 10h	
8	Research Paper Review / Analysis	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters
9.	Poster/ Chart/ Power poin presentation	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills
10	Micro Project	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation
11	Group Discussion / Quiz / Simulation	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
12		Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation=5h Total= 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Other	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Instrumentation Project Management* incorporates;

- Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive

abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: All (Except Electrical Engineering and Allied Branches)
Subject Code: BE05000431

Subject Name: Energy Audit and Management

w.e.f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC-02

Prerequisite:	-
Rationale:	India is one of the world's largest energy consumers and has committed to ambitious targets under the National Action Plan on Climate Change (NAPCC) and COP-26. The Energy Conservation (Amendment) Act, 2022 introduces Carbon Credit Trading, Non-Fossil Consumption Obligations, and mandatory energy audits by BEE-accredited auditors for designated consumers. Gujarat, as a major industrial state with power-intensive sectors such as petrochemicals, textiles, ceramics, and SEZs, requires skilled energy professionals with strong expertise in electrical energy audit and management. This course integrates theory and practice to develop competencies in electrical energy auditing, power quality analysis, demand-side management, renewable integration, and compliance with IEEE, IEC, IS/BIS standards and regulatory frameworks. Thermal and mechanical aspects are covered contextually, while the primary emphasis remains on electrical systems, equipment efficiency, and electrical infrastructure management.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Describe India's energy scenario, legislative framework (EC Act 2001 and Amendment 2022), BEE programmes, and the qualifications and roles of BEE-certified Energy Managers and Energy Auditors.
02	Apply electrical energy audit procedures and instruments to measure and benchmark energy performance of industrial and commercial electrical installations.
03	Analyse power quality parameters — harmonics, power factor, voltage unbalance and flicker — and recommend corrective measures in conformance with IEEE 519, IEC 61000 and relevant IS standards.
04	Evaluate energy efficiency improvement opportunities in electrical equipment and systems including motors, variable frequency drives, pumps, lighting and distribution networks.
05	Prepare an electrical energy audit report with an energy management plan, PAT scheme compliance, renewable energy integration strategy, and financial viability analysis.

Teaching and Examination Scheme:

Teaching-Learning Scheme (inHours per Semester)					TotalCredits = TH/30	AssessmentPatternandMarks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	PBL	Total		ESE (E)	PA/CA (M)	PA/ CA(I)	PBL (I)	ESE(V)	
45	0	0	15	60	2	70	30	00	30	0	130

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

Course Content:

Unit No.	Content	No.of Hours	%of Weightage
1.	**Energy Scenario, Policy and Legislative Framework** Energy scenario in India and Gujarat: electrical energy consumption patterns; sector-wise analysis (industrial, commercial, residential). Energy Conservation Act (EC Act) 2001 — key provisions, designated consumers, penalties. Energy Conservation (Amendment) Act 2022: Carbon Credit Trading Scheme, Non-Fossil Consumption Obligations (RCO/RPO), sustainability building codes. Bureau of Energy Efficiency (BEE): structure and programmes — Perform Achieve and Trade (PAT) scheme, Energy Saving Certificates (ESCerts), Standards and Labelling, UJALA. National Mission for Enhanced Energy Efficiency (NMEEE). State-level energy policies: GUVNL, GEDA, Gujarat Solar and Wind policies, GERC tariff orders. Electricity Act 2003 — relevance to metering and distribution. India's COP-26 commitments and SDG 7.	08	18

2.	**Electrical Energy Audit: Methodology, Instruments and Procedures** Definition and need of energy audit; types — preliminary (walk-through), detailed (diagnostic), investment-grade audit. Energy audit team, scope and boundaries. Data collection, historical energy bills analysis, load profiling, electricity tariff structures (ToD, ToU, HT/LT tariffs). Energy performance indicators (EnPIs), benchmarking and Specific Energy Consumption (SEC). BEE-certified Energy Manager (EM) and Energy Auditor (EA): qualifications, eligibility, accreditation process, statutory duties and responsibilities under EC Act 2001. Measurement instruments: energy analysers (IEC 61557-12 and IS 15884), clamp meters, data loggers, IR thermographic cameras, lux meters, power quality analysers. Measurement of: kWh, kVAh, kVArh, power factor, load factor, demand factor. Sub-metering surveys and feeder loss estimation. Energy audit report structure as per BEE format. Numerical problems on energy consumption analysis and benchmarking.	09	20
3.	**Power Quality Assessment and Improvement** Power quality — definition, importance and financial cost of poor power quality. Voltage sags/swells: causes and classification (IEEE 1159). Harmonics: generation by non-linear loads (VFDs, UPS, rectifiers), Total Harmonic Distortion (THD), harmonic spectrum; limits as per IEEE 519-2022, IEC 61000-3-2, IEC 61000-3-12. Harmonic filters — passive, active, hybrid. Voltage unbalance: causes and effects on motors (IEC 60034-26). Flicker: PST, PLT; IEC 61000-4-15. Power factor improvement: effect on losses and tariff penalty; capacitor bank sizing and placement (IS 13925 / IEEE 18); Automatic Power Factor Controllers (APFC). Power quality measurement instruments: Class A analysers per IEC 61000-4-30.	08	18
4.	**Energy Efficiency of Electrical Equipment and Systems** Electric motors: efficiency classes IE1–IE4 (IS 12615 / IEC 60034-30-1); right-sizing; efficiency testing (IEEE 112); motor rewinding losses. Variable Frequency Drives (VFD): energy savings, selection criteria and harmonic impact. Pumps and fan systems: affinity laws, system curve, Best Efficiency Point (BEP); specific energy consumption; audit methodology (IS 9137). Distribution transformers: energy-efficient amorphous-core types (IS 1180); K-factor transformers for non-linear loads; loading optimization. (Note: transformer loss theory is not re-taught here; only audit-relevant assessment is covered.) Lighting systems: luminous efficacy (lm/W), BEE star rating for LED luminaires; lux-level audit; ECBC lighting power density requirements	09	20

	(IS 3646). HVAC systems: EER, COP and ISEER ratings; BEE star labels; chiller and split-AC energy audit (secondary reference for electrical audit context only).		
5.	**Demand-Side Management, Supply-Side Efficiency and Grid Technologies** Demand-Side Management (DSM): objectives and strategies — load levelling, valley-filling, load shifting, peak-load management; Time-of-Day (ToD) tariff and smart metering (IS 16444); prepaid metering. Smart grid: Advanced Metering Infrastructure (AMI), demand response, Volt/VAR optimization. Power distribution feeder audit: feeder-level loss calculation, capacitor placement optimization, reconductoring economics. Renewable energy integration — overview: rooftop solar PV energy yield estimation (CUF, performance ratio); net metering (Gujarat policy, IS 16221); Battery Energy Storage Systems (BESS) for peak-shaving (IEC 62933); financial analysis: LCOE, simple payback, NPV, IRR. Non-Fossil Consumption Obligation (RCO) for designated consumers (EC Amendment Act 2022).	07	16
6.	**Renewable Energy Integration and Energy Storage for Audit and Management** Rooftop and ground-mount Solar PV systems: components, MNRE/SECI guidelines; grid-connection as per CEA regulations and CEIG norms; IS 16221, IEC 61730, IEC 61215 (PV module testing); net metering, gross metering — Gujarat net metering policy. Wind energy: capacity factor, wind resource assessment; integration issues; IS 61400 series. Battery Energy Storage Systems (BESS): technology comparison (Li-ion, flow batteries, lead-acid); Non-Fossil Consumption Obligation (RCO) compliance for designated consumers under EC Amendment Act 2022. Green hydrogen (introductory) and its role in industrial energy management.	04	08
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
RLevel	**ULevel**	**ALevel**	**NLevel**	**ELevel**	**CLevel**

10	0	20	20	10	10

Where, R:Remember; U:Understanding; A:Application, N:Analyzeand E:Evaluate C:Create (as per Revised Bloom'sTaxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

References/SuggestedLearningResources:

Books:

1. W.R. Murphy & G. McKay, Energy Management (1st ed.), Butterworth-Heinemann / Elsevier, 2007.
2. B.K. De, Energy Management, Audit and Conservation (2nd ed.), Vrinda Publications, 2010.
3. Bureau of Energy Efficiency (BEE), Guide Books for Energy Auditors (Vols. 1–4) — available free at beeindia.gov.in (standard reference for BEE EA/EM examinations).
4. S.C. Tripathy, Electric Energy Utilization and Conservation, Tata McGraw-Hill, New Delhi (latest edition).
5. G.G. Khaparde & V. John, Harmonics and Power Systems, Springer, 2007.
6. W.C. Turner & S. Doty, Energy Management Handbook (7th ed.), Fairmont Press, 2009.
7. Roger C. Dugan et al., Electrical Power Systems Quality (3rd ed.), McGraw-Hill, 2012.
8. L.C. Witte, P.S. Schmidt & D.R. Brown, Industrial Energy Management and Utilisation (1st ed.), Hemisphere Publication, 1988.
9. Patrick, Patrick & Fardo, Energy Conservation Guidebook (1st ed.), Prentice Hall, 1993.
10. J. Douglas Balph, Power Factor Correction Handbook, ON Semiconductor, 2014.
11. E.I. Levi, Polyphase Motors: A Direct Approach to their Design, Wiley, 1985 (motor efficiency reference).
12. IEA, Energy Efficiency 2023 Report, International Energy Agency, Paris, 2023.

Design based Problems (DP)/PBL/Open Ended Problem:

1. Design of a capacitor bank (fixed + automatic stages) for power factor correction of an industrial plant with mixed loads; include protection scheme and cost-benefit analysis.
2. Design and sizing of a rooftop solar PV + BESS system for a 500 kVA industrial facility in Ahmedabad for peak-shaving and net metering; compute LCOE, payback period, and NPV.
3. Prepare an Investment-Grade Energy Audit Report (ASHRAE Level II equivalent) for a selected industry (cement, textile, ceramic or pharma sector in Gujarat) with identification of at least five electrical ECOs and PAT compliance roadmap.
4. Propose a Volt/VAR Optimisation (VVO) scheme for a radial 11 kV distribution feeder; simulate using any power systems tool (PSCAD / ETAP / PowerWorld) and estimate annual energy loss reduction.
5. Evaluate harmonic mitigation strategies for a 100 kW VFD-driven pump station: compare passive filter, active filter and 18-pulse rectifier options on cost, performance and IEEE 519-2022 compliance.

Note: Problems may be solved using hand calculations, MATLAB, ETAP, Homer, PVsyst or similar licensed/open-source simulation tools.

List of Open-Source Software/learning website:

Open-source software:

1. MATLAB / Simulink (MathWorks) — https://www.mathworks.com
2. Homer Pro (Renewable energy system design) — https://www.homerenergy.com
3. PVsyst (Solar PV design and simulation) — https://www.pvsyst.com
4. OpenDSS (Distribution System Simulation) — https://sourceforge.net/projects/electricdss/
5. ETAP (Power systems analysis) — https://www.etap.com (educational licence)
6. GNU Octave — https://www.gnu.org/software/octave/

Web / Digital Resources

Government and Regulatory Portals

1. Bureau of Energy Efficiency — https://beeindia.gov.in (Energy Audit resources, PAT data, BEE tools)
2. Ministry of Power, India — https://powermin.gov.in (EC Act, DSS, national policies)
3. MNRE — https://mnre.gov.in (solar / wind grid integration guidelines)
4. GEDA Gujarat — https://geda.gujarat.gov.in (state-level renewable energy policy)
5. GERC — https://www.gercin.org (tariff orders, net metering regulations)
6. Central Electricity Authority — https://cea.nic.in (grid standards, load generation balance report)

NPTEL / SWAYAM Courses

1. NPTEL: Energy Efficiency, Acoustics and Daylighting in Buildings — https://nptel.ac.in
2. NPTEL: Power Electronics — (for understanding inverter-based power quality aspects)
3. NPTEL: Power System Analysis — (for distribution loss estimation context)
4. BEE e-learning portal: https://beeindia.gov.in/content/energy-auditors

Standards Bodies

1. IEEE Xplore Digital Library — https://ieeexplore.ieee.org
2. IEC Standards — https://www.iec.ch
3. Bureau of Indian Standards — https://www.bis.gov.in

SDGs Relevant to Energy Audit & Management

SDG	Goal Title	Connection to Energy Audit & Management Syllabus
SDG 3	Good Health & Well-Being	Safe handling of electrical equipment; lab safety protocols during energy audits
SDG 4	Quality Education	BEE mock exams, NPTEL/BEE e-learning, simulation-based practicals, self-learning activities
SDG 7	Affordable & Clean Energy	Entire course — energy auditing, RE integration, demand-side management, energy efficiency
SDG 8	Decent Work & Economic Growth	BEE-certified Energy Auditor/Manager careers; PAT scheme compliance in industry
SDG 9	Industry, Innovation & Infrastructure	Motor efficiency (IE4), smart metering (AMI), FACTS devices, grid modernisation
SDG 11	Sustainable Cities & Communities	ECBC building energy codes, smart grid/DSM for urban feeders, lux-level audits in buildings
SDG 12	Responsible Consumption & Production	SEC benchmarking, load profiling, VFD adoption, transformer optimisation, AT&C loss reduction
SDG 13	Climate Action	EC Act 2022 carbon credits, COP-26 commitments, RE integration, NMEEE, green hydrogen
SDG 17	Partnerships for the Goals	Industry–institution linkage via BEE, GEDA, GERC; international standards (IEC/IEEE/ISO)

Activities Suggested for Self-Learning:

Sl. No.	PBL Activity	Activity	Hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Industry Visit: Conduct a walk-through energy audit of a nearby industrial unit (textile, pharma, ceramics, engineering) or electricity distribution substation. Document electrical load inventory, meter readings, and preliminary energy conservation opportunities (ECOs).	Visit=5h, Report=5h, Total=10h	Quality of one-line diagram sketched, completeness of load inventory, clarity of ECO identification, adherence to BEE audit format.
2	Survey & Mirco Project	Power Quality Measurement Campaign: Use portable PQ analyser (or simulated data) to conduct a 24-hour power quality survey of the institute's electrical installation; prepare report with IEEE 519-2022 compliance assessment and	Measurement=5h, Report=5h, Total=10h	Accuracy of captured parameters, correct application of IEEE 519 limits, quality of mitigation

		recommendations.		recommendations.
3	Assignment/ Technical Writing / Research Writing	Numerical Assignments: Minimum 5 assignments covering — tariff analysis, power factor correction sizing, motor energy savings calculation (VFD vs. DOL), transformer all-day efficiency, harmonic filter design, solar PV yield estimation, NPV/IRR of ECO.	5 × 2h = 10h	Correctness of methodology, application of appropriate standards, logical presentation.
4	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Simulation Task: Model and simulate a power distribution feeder with capacitor placement in OpenDSS or ETAP; compare losses before and after VAR compensation. Alternatively, simulate harmonic spectrum and passive filter design in MATLAB/Simulink.	5 × 2h = 10h	Simulation accuracy, proper interpretation of results, correct use of software tools, documentation quality.
5	MOOC Course	Online Certification: Complete at least 10 hours of an online course related to energy audit, power quality, renewable energy or smart grid (NPTEL, Coursera, edX, BEE e-learning platform).	10h	Certificate of completion + quiz/viva on course content.
6	Seminar / Poster Presentation	Technical Seminar / Poster Presentation: Prepare and present a 10-minute seminar or technical poster on a current topic — examples: 'Impact of EV Charging on Grid Power Quality', 'Rooftop Solar + BESS for SMEs in Gujarat', 'Carbon Credit Trading under EC Act 2022', 'IE4/IE5 Motor Adoption Roadmap in India'.	Research=5h, Preparation=5h, Total=10h	Technical accuracy, use of standards and data, communication clarity, response to questions.
7	BEE Mock Examination	BEE EA / EM Mock Examination: Attempt one full-length mock examination of BEE Energy Auditor (Paper I or Paper II) under examination conditions; review answers with faculty.	5h	Score and quality of review noting error patterns, identification of weak areas for improvement.
8	Patent Search / Literature Review	Patent / Literature Review: Search 5–8 recent patents or IEEE/Scopus papers on a chosen topic (e.g., smart energy metering, demand response algorithms, AI-based energy forecasting, advanced APFC controllers); prepare a one-page annotated bibliography.	10h	Relevance of papers selected, quality of critical analysis, identification of research gaps.

Note:
Notes: (i) All activities must be directly related to electrical energy audit and management. (ii) Suggestive hours may be redistributed by faculty, but total hours are fixed. (iii) Evaluation rubrics shall be prepared and displayed by the concerned faculty. (iv) All records must be maintained at institute level and produced on demand. (v) Digital submission via Microsoft Teams, Moodle or institute LMS is encouraged. (vi) In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject Energy Audit and Management incorporates;

- Mini Project – 10 Marks
- Micro Project and – 5 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of Energy Audit and Management. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice. (vii) The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Civil Engineering and Allied Branches)
Subject Code: BE05000441
Subject Name: Application of RS and GIS in Engineering

w. e. f. Academic Year:	2024-25
Semester/Year	5
Category of the Course:	MOPEC

Prerequisite:	Nil
Rationale:	The subject of RS–GIS includes interdisciplinary, practical, and aligned with current industry trends topics. It incorporates modern tools, open-source software, and freely available geospatial data to ensure accessibility and hands-on learning. The content is broadened to cater diverse branches such as Environmental, IT, and AI/ML. Emphasis is given to real-world applications like climate change, smart cities, and disaster management. The syllabus also promotes higher-order thinking and problem-solving skills, enhancing student employability and relevance to global sustainability goals.

Course Outcome:
After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
CO-1	Identify and analyze real-world engineering problems where RS & GIS can be applied using modern datasets.	U, N
CO-2	Apply image interpretation and processing using open tools.	A
CO-3	Integrate spatial and non-spatial datasets from multiple free sources to develop GIS-based solutions.	R, U, N
CO-4	Design and implement spatial analysis workflows for solving engineering problems using GIS tools.	A, N, C
CO-5	Evaluate and communicate geospatial solutions effectively using maps, reports, and digital platforms.	E

Teaching and Examination Scheme:

Teaching Scheme (in Hours)					Total Credits =TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL(I)	ESE (V)	
45	0	0	15	60	2	70	30	20	00	00	120

where L = Lecture, T= Tutorial, P= Practical, PBL=project base learning, TH = Total Hours, ESE = end- Semester Examination, PA = Progressive Assessment/

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	FUNDAMENTALS OF REMOTE SENSING: • Introduction to Remote Sensing: Definition, components, and role in multidisciplinary applications. • Types of Remote Sensing: Active and Passive systems with real-world examples (weather radar, satellite imaging). • Electromagnetic Spectrum: Basic concepts and relevance in environmental monitoring, imaging systems, and sensor design. • Interaction of EMR with Atmosphere: Scattering, absorption, atmospheric windows and implications for weather, climate, and communication systems. • Interaction of EMR with Earth's Surface: Spectral signatures of natural and built features (vegetation, water, soil, urban areas). • Introduction to freely available satellite data and platforms (Bhuvan, USGS, Copernicus). • Basic visual interpretation using tools like Google Earth.	7	12
2	REMOTE SENSING DATA PRODUCTS: • Types and classification of remote sensing data products (optical, thermal, microwave). • Spatial, spectral, radiometric, and temporal resolutions. • Freely available RS datasets: Bhuvan, USGS Earth Explorer, Copernicus Open Access Hub. • Overview of modern satellite missions (e.g., NISAR, Sentinel, Landsat). • Introduction to UAV/Drone-based remote sensing and its applications. • Data formats, metadata, and data preprocessing basics.	6	12
3	INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEM: • Definition and scope of GIS in multidisciplinary applications (engineering, environment, IT, business analytics). • Components of GIS (hardware, software, data, methods, people). • Spatial vs Non-spatial data and their integration. • Data input/output methods (manual, GPS, remote sensing, APIs). • Data standards and formats (Shapefile, GeoJSON, KML). • Coordinate systems and map projections; georeferencing concepts. • Introduction to spatial data infrastructure and open data ecosystems.	6	12

4	RS-GIS SOFTWARE AND OPEN PLATFORMS: • Overview of GIS and image processing software (QGIS, SNAP, Google Earth Engine). • Capabilities and limitations of open-source vs commercial tools. • Data management and visualization in GIS platforms. • Spatial data models: Raster and Vector. • Attribute data management and database basics. • Open GIS data sources: OpenStreetMap, Natural Earth, Bhuvan. • Mobile GIS tools (QField, SW Maps) and field data collection. • Introduction to Web GIS and cloud-based geospatial platforms.	6	12
5	IMAGE INTERPRETATION AND DIGITAL IMAGE PROCESSING: • Digital image fundamentals: sensors, image formats, and visualization. • Visual interpretation techniques: tone, texture, pattern, shape, association using tools like Google Earth. • Image processing techniques: NDVI, NDWI, NDBI, change detection. • Image enhancement: contrast stretching, filtering, band combinations. • Image rectification and restoration. • Introduction to AI/ML-based classification concepts (non-mathematical overview).	7	18
6	GIS SPATIAL DATA ANALYSIS: • Spatial and non-spatial data operations in GIS. • Raster vs Vector analysis in QGIS. • Terrain analysis using DEM: slope, aspect, hillshade, drainage network. • Introduction to Python in GIS (conceptual exposure for IT/AI students). • Use of GIS plugins and processing tools. • Basics of spatial modeling and decision support systems.	7	18
7	APPLICATION OF REMOTE SENSING & GIS: • Smart cities, urban analytics, and infrastructure planning. • Climate change monitoring and sustainability assessment. • Disaster management: floods, fires, earthquakes (real-time monitoring). • Agriculture and environmental applications (crop monitoring, deforestation). • Introduction to Web-GIS and geospatial dashboards. • Case studies using free datasets (Bhuvan flood maps, Sentinel LULC mapping).	6	16

	• Emerging trends: AI/ML in geospatial analysis, IoT integration, big geospatial data.		

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
5	25	30	15	10	15

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

Reference Book:

1. Lilliesand T.M. and Kiefer R.W., Remote Sensing and image Interpretation , John Wiley and Sons, New York, 2004.
2. Burrrough P.A and McDonnel R.A., Principles of Geographic Information Systems, Oxford university press, 1998.
3. A.M. Chandra and S.K. Ghosh,Remote Sensing and Geographical information System, Narosa Publishing House, New Delhi, 2006.
4. Bhatta B., Remote Sensing and GIS, Oxford University Press, New Delhi, 2008
5. Stan Aronoff, "Geographical Information Systems", WDL Publications, Ottawa, Canada, 1989.
6. Agrawal N. K., Essentials of GPS, Spatial Network Pvt. Ltd., Hydrabad, 2004.
7. Lo C.P. and Yeung Albert K.W., Concepts and Techniques of Geographical Information Systems, Prentice-Hall of India Pvt. Ltd. New Delhi, 2006.

Sustainable Development Goals Addressed:

SDG 4 – Quality Education
- Promotes modern, interdisciplinary, and skill-based geospatial education.

SDG 6 – Clean Water and Sanitation
- Supports water resource mapping, watershed analysis, and hydrological monitoring.

SDG 9 – Industry, Innovation and Infrastructure
- Introduces advanced technologies like UAVs, AI/ML, and geospatial innovation.

SDG 11 – Sustainable Cities and Communities
- Enables urban planning, smart city development, and infrastructure analysis.

SDG 13 – Climate Action
- Supports climate monitoring, disaster management, and environmental sustainability.

SDG 15 – Life on Land
- Helps in vegetation mapping, biodiversity monitoring, and land management.

Open-source software and website:

1. http://nptel.ac.in/
2. Indian Data Sources: Bhuvan Geoportal URL: https://bhuvan.nrsc.gov.in, Data: IRS imagery, thematic maps, flood maps, LULC
3. Global Data Sources:
    a. USGS Earth Explorer URL: https://earthexplorer.usgs.gov, Data: Landsat, SRTM DEM, MODIS.
    b. Copernicus Open Access Hub URL: https://scihub.copernicus.eu, Data: Sentinel-1 (SAR), Sentinel-2 (optical), Sentinel-3.
4. High-resolution and free source: NASA Earthdata URL: https://earthdata.nasa.gov, Data: MODIS, TRMM, GPM, climate data
5. Free GIS Data Sources:
    a. OpenStreetMap URL: https://www.openstreetmap.org, Data: Roads, buildings, infrastructure.
    b. Editable and crowd-sourced: Natural Earth URL: https://www.naturalearthdata.com, Data: Administrative boundaries, physical features.
    c. DIVA-GIS URL: https://www.diva-gis.org, Data: Country-level GIS datasets.
    d. FAO GeoNetwork: URL: https://www.fao.org/geonetwork, Data: Soil, agriculture, water resources.
6. Hydrology & Climate Data:
    a. CHIRPS URL: https://www.chc.ucsb.edu/data/chirps, Data: Rainfall time-series.
    b. GPM (Global Precipitation Measurement) URL: https://gpm.nasa.gov, Data: Satellite rainfall
    c. WorldClim URL: https://www.worldclim.org, Data: Temperature, precipitation.
7. Free GIS & Remote Sensing Software
    a. Desktop GIS Software: QGIS URL: https://qgis.org.
    b. GRASS GIS URL: https://grass.osgeo.org, Advanced spatial analysis
    c. SAGA GIS URL: https://www.saga-gis.org, Strong in DEM analysis
8. Remote Sensing Software:
    a. SNAP URL: https://step.esa.int, Ideal for Sentinel data.
    b. Orfeo Toolbox URL: https://www.orfeo-toolbox.org, Image classification & ML
9. Cloud-Based Platforms: Google Earth Engine URL: https://earthengine.google.com,
10. Mobile GIS Apps (Field Data Collection): QField, Android app for field surveys. SW Maps Easy field data collection. Google Earth Visualization & interpretation

Suggested Course Practical/Assignment List: Students should follow the DTE laboratory manual for assignments and practical.

Suggested list of Experiment:

1. Downloading data from USGS Earth Explorer / BHUVAN
2. Digitization using QGIS + OpenStreetMap
3. Field data collection using QField

4. NDVI calculation using Sentinel data
5. Simple Web Map creation/ Country map

Suggested Micro/Mini Projects under Project Based Learning (PBL)			
A. Beginner Level Micro Projects:			
Sr. No.	Project Title	Tools/Data Sources	Approximate Hours
1	Land Use/Land Cover Mapping of Local Area	QGIS + Sentinel Data	5
2	Mapping Water Bodies using NDWI	QGIS/SNAP + Sentinel	5
3	Urban Growth Analysis using Google Earth Images	Google Earth + QGIS	5
4	Road Network Mapping using OpenStreetMap	OSM + QGIS	5
5	Tree Cover Mapping in Campus Area	Google Earth + QGIS	7.5
6	Flood-Prone Area Identification using DEM	SRTM DEM + QGIS	5
7	Campus Utility Mapping	QField + QGIS	7.5
8	Change Detection of Nearby Area using Satellite Images	Landsat/Sentinel	5
9	Mapping Solid Waste Dumping Locations	Mobile GIS + QGIS	5
10	Village/City Base Map Preparation	OSM + QGIS	5
B. Environmental & Sustainability Projects:			
Sr. No.	Project Title	Tools/Data Sources	
11	Monitoring Vegetation Health using NDVI	Sentinel-2 Data, QGIS, SNAP	10
12	Rainfall Trend Visualization using CHIRPS Data	CHIRPS Rainfall Data, QGIS, Google Earth Engine	10
13	Air Pollution Mapping using Open Data	CPCB/OpenAQ Data, QGIS	5
14	Wetland Inventory Mapping	Landsat/Sentinel Data, QGIS	7.5
15	Watershed Delineation and Analysis	SRTM DEM, QGIS, GRASS GIS	7.5
16	Climate Vulnerability Mapping of Local Area	WorldClim Data, QGIS	7.5
17	Heat Island Mapping using Thermal Data	Landsat Thermal Bands, QGIS	5
18	Deforestation/Green Cover Change Study	Landsat Time-Series Data, Google Earth Engine	5

C. Smart City & Urban Analytics Projects:			
Sr. No.	Project Title	Tools	
19	Smart Parking Location Suitability Analysis	QGIS	5
20	Public Transport Accessibility Mapping	OSM + QGIS	5
21	Hospital/School Service Area Analysis	Buffer Analysis	5
22	Traffic Congestion Mapping using GPS Data	Mobile GIS	5
23	Urban Sprawl Analysis using Satellite Images	Landsat/Sentinel	5
24	Site Suitability Analysis for EV Charging Stations	GIS Overlay Analysis	5
D. Water Resources Engineering Projects:			
Sr. No.	Project Title	Tools/Data	
25	Reservoir Area Monitoring using Satellite Data	Sentinel	7.5
26	River Course Change Detection	Landsat Time Series	7.5
27	Flood Inundation Mapping using Bhuvan Data	Bhuvan + QGIS	5
28	Groundwater Recharge Zone Mapping	DEM + GIS Layers	10
29	Rainwater Harvesting Site Selection	GIS Overlay	5
30	Stream Network Extraction using DEM	SRTM + QGIS	5
E. IT / Computer / AI-ML Oriented Projects			
Sr. No.	Project Title	Focus Area	
31	Web GIS Dashboard for Local Area	Web GIS	5
32	Satellite Image Classification using ML (Basic)	AI/ML	10
33	Python-based GIS Automation Workflow	Python + QGIS	5
34	GeoJSON-based Interactive Map Development	Web Mapping	5
35	GPS-based Mobile Data Collection App Study	Mobile GIS	10
36	AI-based Land Cover Classification (Conceptual)	AI in GIS	5
37	Spatial Database Creation using PostgreSQL/PostGIS	Spatial DBMS	5
F. Disaster Management Projects			
Sr. No.	Project Title	Application	
38	Flood Hazard Zonation Mapping	Disaster Management	7.5
39	Earthquake Vulnerability Mapping	Risk Analysis	5
40	Forest Fire Risk Mapping	Environmental Monitoring	5
41	Cyclone Tracking Visualization using Open Data	Climate Studies	5

42	Emergency Route Planning using Network Analysis	GIS Routing	5
G. Advanced/Open Innovation Projects			
Sr. No.	Project Title	Platform	
43	Google Earth Engine-based Time Series Analysis	GEE	5
44	UAV/Drone Image Mapping Workflow	Drone Data	5
45	Smart Agriculture Monitoring System	GIS + IoT	5
46	Multi-Criteria Decision Analysis for Site Selection	MCDA	5
47	Interactive SDG Monitoring Map using GIS	Sustainability	10
48	Digital Twin Concept using GIS Data	Emerging Tech	10

Recommended Structure for PBL

Each project may include:

1. Problem Statement
2. Objectives
3. Data Collection
4. Methodology
5. GIS/RS Analysis
6. Results & Maps
7. Conclusion

Expected Learning Outcomes from PBL

Students will learn:

- Geospatial problem solving
- Open-source GIS workflows
- Spatial data analysis
- Teamwork & reporting

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Civil Engineering and Allied Branches)
Subject Code: BE05000451
Subject Name: Occupational Health and Safety Management

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Multidisciplinary Open Professional Electives Course

Prerequisite:	Knowledge of fundamentals of safety and safety standards
Rationale:	To learn about occupational health hazards, industrial safety practices, accident prevention techniques, and risk management approaches for ensuring worker health, safety, and sustainable industrial operations.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Recognize the occupational health related hazards in the workplace	20%
CO-2	Understand the Concept, Philosophy & Psychology for safety management	20%
CO-3	Discuss Electrical safety, fire & explosions, accidental hazards and PPE	40%
CO-4	Explain Hazards & Risk Identification, Assessment & Control Techniques	20%

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	0	0	15	60	2	70	30	0	30	0	130

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Content:

Sr. No.	Content	Total Hrs
A	**OCCUPATIONAL HEALTH**	
1	• Classification of occupational health hazards, routes of entry of toxic material into human body, dangerous properties of chemical and their health effects, Hierarchy of hazard control: Elimination, Substitutions, Engineering Control, Administrative Control, Personal Protective Equipments (PPE) • Work environmental sampling and its types, Permissible exposure limits,	**12**

	Threshold limit value, lethal dose and lethal concentration, • Ergonomics, constituents of ergonomics, application of ergonomics for safety & health, • Occupational diseases due to metals & dusts, fumes & chemical compounds. • Physical Aspect of Work Environment: Exposure, Assessment/Effects & Control of Noise, Vibration, Heat Stress, Poor Illumination, Radiation	
B	**SAFETY MANAGEMENT**	
1	**Concept, Philosophy & Psychology of safety:** Concept of safety, Nature of concept of safety, Philosophy of safety, safety terminology, philosophy of total safety concept, safety psychology, accident causative factors, general psychological factors, salient points of factories act 1948	**4**
2	**Safety Management:** Concept of management, element of management, functions, management principles, safety management & its responsibilities, safety organization	**4**
3	**Accident Causes and prevention:** Causation, Accident problem, Reasons for prevention, factors impending safety, accident prevention	**3**
4	**Electrical Safety:** Electricity and Hazardous, Indian standards, effects of electrical parameters on human body, safety measures for electric works	**3**
5	**Fire & Explosion:** Fire phenomena, classification of fire and extinguishers, statutory and other standards, fire prevention & protection system, explosion phenomena, explosion control devices, fire awareness signs	**5**
6	**Personal Protective Equipment:** Need of PPE, Indian standards, factors of selection of PPE, non-respiratory equipments, respiratory equipments.	**4**
7	**Hazards & Risk Identification, Assessment & Control Techniques:** Hazards, Risks & detection techniques, Preliminary hazard analysis (PHA) & hazard analysis (HAZAN), failure mode effect analysis (FMEA), Hazard and operability (HAZOP) study, Hazard ranking (DOW & MOND index), Fault tree analysis, Event tree analysis (ETA), major accident hazard control, on-site and off-site emergency plans	**10**
	TOTAL	**45**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**30**	**10**	**00**	**00**	**00**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of Occupational Health and safety Management directly contributes to

SDG 3	**Good Health and Well-Being** by equipping students with knowledge of occupational health hazards, industrial hygiene, ergonomics, and workplace safety measures to ensure healthy and safe working environments.
SDG 8	**Decent Work and Economic Growth** by developing understanding of accident prevention, safety management systems, PPE, and hazard control techniques that promote safe and productive workplaces.
SDG 9	**Industry, Innovation and Infrastructure** by providing knowledge of industrial safety engineering, hazard identification, risk assessment methods, and modern safety management practices for sustainable industrial operations.
SDG 11	**Sustainable Cities and Communities** by enhancing awareness of fire safety, explosion control, and emergency planning to minimize industrial risks and improve community safety.
SDG 12	**Responsible Consumption and Production** by promoting safe handling of chemicals, exposure control, and responsible industrial practices for reducing occupational and environmental hazards.
SDG 13	**Climate Action** by strengthening emergency preparedness, industrial risk reduction, and pollution prevention practices that support environmentally sustainable industrial development.

Reference Books:

1. Fundaments of Industrial safety & health by Dr. K. U. Mistry.
2. Industrial Safety & Environmental Management System R. K. Jain & Prof. Sunil S. Rao, Publisher: Khanna Publishers
3. Social & Preventive Medicines by Yashpal Bedi.
4. Industrial & occupational Safety, Health & Hygein - by AHommadi.
5. Occupational Health, a Practical Guide for Managers -by Ann Fingret & Akin Smith.
6. Environmental Health & Technology - by Y P Kudesia & Ritu Kudesia.
7. Environment & Health by Norman M Triff

List of Open-Source Software/learning website:

- NPTEL courses links
  https://onlinecourses.nptel.ac.in/noc20_mg43/preview
  https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_mg52

- Occupational Safety and Health Administration (OSHA) - PPE, exposure standards, chemical hazards - https://www.osha.gov

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL Category	Name of the Activity	No. of Hours	Evaluation Criteria
1	Seminar	Seminar on Occupational Diseases (e.g., silicosis, asbestosis, lead poisoning)	Duration :Total= 10 hrs	Based on content and presentation skills

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Civil Engineering and Allied Branches)
Subject Code: BE05000451
Subject Name: Occupational Health and Safety Management

Sr. No.	PBL Category	Name of the Activity	No. of Hours	Evaluation Criteria
2	Mini Project	Fire Safety Audit and Emergency Plan Preparation (college lab/Commercial Compliex/School/Appartment/Hospital/Hostel)	Audit: 8 hrs + Plan preparation: 2 hrs = 10 hrs	Based on fire safety audit report, fire risk identification, and prepared emergency planning effectiveness
3	Mini Project	Ergonomic Assessment of Workplace (college lab/office/Workplace for industry worker)	Survey: 5 hrs + Analysis: 5 hrs = 10 hrs	Assessment based on analysis report and application of ergonomic principles
4	Technical Report Writing	Preparation of Material Safety Data Sheet (MSDS) for selected chemical	Study:3 hrs + Documentation : 2 hrs = 5 hrs	Evaluation based on completeness and correctness of MSDS documentation
5	Case Study Analysis	Accident Analysis using Root Cause Techniques (FTA/ETA/FMEA)	Case study: 8 hrs + Analysis: 2 hrs = 10 hrs	Based on analytical report and correctness of applied techniques
6	Industry Visit	• PPE Selection and Compliance Study in different industries • Electrical Safety Inspection and Risk Mapping	Survey: 5 hrs + Report Preparation: 5 hrs = 10 hrs	• Based on report submission and justification of PPE selection • Based on inspection report and identification of Electric hazards
7	Poster / Chart / PowerPoint Presentation	Poster/Presentation (PPE, electrical safety, fire and explosions, safety mgmt etc.)	Preparation & Presentation= 10 hrs	Based on presentation quality, technical content, and communication skills
8	Video Based Learning	Technical Video based learning related to the subject	Duration of video: 5 hrs	Multiple choice questions-based Assessment
9	Group Discussion / Quiz	Software-based Risk Assessment (ALOHA/other tools)	Practice: 6 hrs + Report: 4 hrs = 10 hrs	Based on model application, output interpretation, and report submission
10	Group Discussion / Quiz	Group Discussion on Safety Regulations & Acts (Factories Act 1948, GFR, ILO, etc.)	Discussion :5 hrs	Based on participation, technical understanding, and communication skills

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Mechanical Engineering and Allied Branches)
Subject Code: BE05000471
Subject Name: Oil Hydraulic and Pneumatics

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC

Prerequisite:	Nil
Rationale:	This course provides a comprehensive introduction to fluid power, including both oil hydraulics and pneumatics. The course gives an idea about the basic system working on fluid power and compressed air. Also, different valves related to hydraulic and pneumatic systems are discussed in the syllabus. The subject is also useful for designing the various hydraulic and pneumatic circuits for various engineering applications.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Explain the fundamentals of hydraulic and pneumatic systems, including their principles, components, symbols, electrical elements, advantages, limitations, and applications in engineering systems. OR Explain basic components, elements, symbols, and applications of electric, hydraulic, and pneumatic systems.	20
CO-2	Discuss various types of hydraulic oil, air filter, construction & working of the hydraulic pumps, hydraulic motors, control components in hydraulic systems, and actuators. OR Apply the principles of hydraulic oils, filtration systems, pumps, motors, valves, and actuators for the design, operation, and maintenance of hydraulic systems in engineering applications.	35
CO-3	Illustrate the function, construction & working of the various components of pneumatic systems.	20
CO-4	Design hydraulic, pneumatic, and actuator circuits for specific applications.	15
CO-5	Apply automation principles in hydraulic and pneumatic systems, including circuit design and simulation using relevant software tools.	10

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	00	00	15	60	02	70	30	00	30	00	130

Content:

Sr. No.	Content	Total Hrs
1	**Introduction To Hydraulics and Pneumatics Systems:** Introduction, Basic system of Hydraulics, Major advantages and disadvantages, Comparison among electrical, hydraulics, and pneumatics systems, History of development of fluid power, Principles of hydraulic fluid power, Hydraulic symbols, Electrical elements used in hydraulic circuits. Basic requirements for pneumatic systems, Basic symbols of pneumatic systems, Electrical elements used in pneumatic systems, Application of hydraulic and pneumatic systems.	**08**
2	**Hydraulic Oils and Filters:** Purpose of hydraulic oil, Types of hydraulic oil, Classification mineral based, Fire-resistant & biodegradable oils, Ideal characteristics of hydraulic oil, Maintenance of hydraulic oil, Filters, Types of filters, Material used for filter, Location of filter, Contaminations.	**06**
3	**Hydraulic Pumps, Motors, Valves, and Actuators:** **Hydraulic Pumps:** Classification of hydraulic pumps, Pump specifications. Construction & working of gear pump, vane pump, radial piston pump, axial pump, Maintenance & troubleshooting. **Hydraulic Motors:** Hydraulic motors, Constructional features, and performances of gear motor, vane motors, and piston motors. **Control Components in Hydraulic Systems:** Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Cartridge valves, Pressure intensifiers, Reservoirs, Accumulators. **Actuators:** Types of hydraulic actuators, Selection criterion of actuators, Linear and rotary Actuators.	**10**
4	**Pneumatics System:** **Air Preparation and Service Unit:** Types & selection criteria for air compressors, Air receiver, Pipeline layout, Air filter, Air dryer, Pressure regulator, and Lubricator (FRL unit). **Pneumatic Cylinders and Motors:** Types of pneumatic cylinders & air motors, Cushion assembly, Mounting arrangements, **Pneumatic Valves:** Pneumatic direction control valves, Quick exhaust, Time delay shuttle and Twin pressure valves.	**10**
5	**Circuit Design and Analysis:** Basic hydraulic circuits, Industrial hydraulic circuits, Power losses in flow control circuits, Basic pneumatic circuits, Development of single actuator circuits, Development of multiple actuator circuits, Cascade method for sequencing.	**6**
6	**Automation and Simulation of Hydraulics and Pneumatics:** Introduction to Automation in hydraulic and Pneumatic Systems, Case study of automation using hydraulics and pneumatics. Introduction to software of hydraulic and pneumatic systems, Circuit designing in software, Simulation in software, Simulation with actual components using software like automation in industry.	**5**
	Total	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**35**	**10**	**5**	**5**

R: Remembrance; U: Understanding; A: Application, N: Analyze, and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from the above table.

The syllabus of Oil Hydraulic and Pneumatic System directly contributes to

Chapter / Topic	SDG No.	Sustainable Development Goals
Chapter-1	**SDG-7** **SDG-9**	**Ensure access to affordable, reliable, sustainable and modern energy:** Application of hydraulic, electrical and pneumatic systems. **Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation:** by knowledge of efficient hydraulic, electrical and pneumatic systems in industrial automation and infrastructure.
Chapter-2	**SDG 12**	**Ensure sustainable consumption and production patterns:** Use of biodegradable and fire-resistant oils reduces environmental pollution.
Chapter-3 and Chapter-4	**SDG-7** **SDG-9**	**Ensure access to affordable, reliable, sustainable and modern energy:** Students able to find affordable, reliable, sustainable and modern components in hydraulic and pneumatic systems. **Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation:** by knowledge of efficient pumps, motors, cylinder valve and air preparation unit improve energy utilization.
Chapter-5	**SDG 12**	**Ensure sustainable consumption and production patterns:** Optimized circuit design minimizes energy losses and improves efficiency.
Chapter-6	**SDG 9**	**Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation:** Students able to sustainable industrialization and foster innovation by automation in hydraulic and pneumatic systems and optimize design in software.

Reference Books:

1. Hydraulic and Pneumatic Power and Control by Franklin D. Yeaple, McGraw Hill.
2. Industrial Hydraulics by John Pippenger and Tyler Hicks, McGraw-Hill.
3. Oil Hydraulic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
4. Hydraulic and Pneumatics, Andrew Parr, Elsevier (3rd Edition)
5. Fluid Power with Applications by Anthony Esposito, Pearson.
6. Fluid Power: Generation, Transmission and Control, Jagadeesha T., Thammaiah Gowda, Wiley.
7. The Analysis & Design of Pneumatic Systems by B. W. Anderson, John Wiley.
8. Hydraulic and Pneumatic Controls: Understanding made Easy, K.ShanmugaSundaram, S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)
9. Basic Pneumatic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
10. Electrohydraulic Servomechanisms by Allen C. Morse, McGraw-Hill, 1963.

List of Open-Source Software/learning website:

1. https://nptel.ac.in/courses/112105046
2. https://onlinecourses.nptel.ac.in/noc26_me51/preview
3. https://onlinecourses.nptel.ac.in/noc21_me51/preview
4. https://onlinecourses.nptel.ac.in/noc25_me38/preview
5. http://acl.digimat.in/nptel/courses/video/112106300/112106300.html
6. http://elearn.psgcas.ac.in/nptel/courses/video/112105047/112105047.html
7. Hopsan, Free & open-source simulation tool, used for fluid power systems (hydraulics & pneumatics).
8. Bosch Rexroth Scheme Editor, Free software for pneumatic and hydraulic circuit design.
9. HydraForce i-Design, Free tool for hydraulic circuit and manifold design
10. Elmer FEM Solver, Free multiphysics tool, Can simulate fluid flow, heat transfer, and hydraulic systems
11. Code_Saturne, Open-source CFD software, Used for fluid flow and hydraulic analysis

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	15h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	15h (need to be changed as per total PBL hours)	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	8h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, quality of report and demonstration

4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness of submitted assignment
7.	Group Discussion / Quiz / Simulation	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
9.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster / Chart / PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1h – 3h per topic	Based on performance in group discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.

16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research laboratory visit	Expert lecture/session	Duration 3h For attending the lecture/session– 2h and for report writing 1h	Based on the proof of attendance and report submitted
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing / Research Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report	Based on report quality and understanding of the relevant Indian Standard(s).

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Oil Hydraulic and Pneumatics compulsorily incorporates Micro Project and 5 marks as PBL activities** These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Mechanical Engineering and Allied Branches)
Subject Code: BE05000481
Subject Name: Project Management

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC-1

Prerequisite:	Nil
Rationale:	Project Management is an essential subject that prepares students to effectively plan, organize, and control projects in various engineering and industrial domains. It provides a structured approach to managing resources, time, cost, and quality to achieve project objectives efficiently. In modern industries, where projects are complex and multidisciplinary, the application of project management principles is crucial for successful execution. The subject introduces students to key concepts such as project life cycle, scheduling techniques (CPM and PERT), risk analysis, budgeting, and team coordination. It also enhances soft skills like leadership, communication, and decision-making, which are vital for managing teams and stakeholders. By learning Project Management, students gain the ability to handle real-world challenges, improve productivity, and minimize risks. This subject increases employability and prepares graduates for careers in engineering, IT, construction, manufacturing, and entrepreneurship, aligning academic knowledge with industry requirements.

Course Outcomes: students are able to

Sr. No.	CO statement
CO-1	Explain the definition of a project, its key characteristics, and distinguish between project management and general management.
CO-2	Analyze and design effective project organizational structures and comprehensive project plans
CO-3	Develop and justify project budgets by applying appropriate cost estimation methods, while accounting for uncertainty and risk to ensure financial feasibility and control.
CO-4	Evaluate and optimize project schedules by applying resource allocation, resource leveling, multi-project scheduling, and project crashing techniques to achieve efficient time–cost balance and improved project execution.
CO-5	Apply Earned Value Analysis (EVA) techniques to evaluate project performance in terms of cost and schedule.

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Mechanical Engineering and Allied Branches)
Subject Code: BE05000481
Subject Name: Project Management

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	00	00	15	60	2	70	30	00	30	00	130

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Content:

Sr. No.	Content	Total Hrs
1	**Project Management:** Definition of project, Project Management Vs. General Management, Three goals of project, The life cycle of projects, Selecting projects to meet organizational goals, Confronting Uncertainty, Project portfolio process, An approach to Project Formulation Characteristics of projects, Characteristics of project management, Projects in contemporary organizations, Project life cycle.	8
2	**Organizing and Planning the project:** Organizing: The PM's Roles, The PM's responsibility to the project, Selection of a Project Manager, Cross-functional team, Dedicated project organization, Influence project organization, Matrix organization, Advantages and disadvantages of project organizations, Selection of Project organization, Fitting projects into the parent organization. Work Breakdown Structure (WBS), Integration of project organization and WBS, WBS and responsibility matrix. Planning: The contents of a project plan, The planning process-overview, The planning process. The work breakdown structure and other aids, Multidisciplinary Teams: Balancing Pleasure and Pain.	12
3	**Budgeting the Project:** Methods of budgeting, Cost estimating, Improving Cost Estimates, Budget Uncertainty and risk management.	06
4	**Project Network Theory:** Gantt chart, Milestone chart, Network techniques: PERT and CPM, AON and AOA representation, three-time estimates, Probability distributions for time computation, Probability of project completion, Time scale version of network, Early start and late start schedules, Extensions to PERT/CPM, Project Simulation, Resource allocation, Resource loading and levelling, Constrained resource scheduling, Multi-project scheduling and resource allocation, Crashing a project.	12

5	**Monitoring and Controlling the Project:** The plan-monitor-control cycle, Data collection and reporting, Earned Value Analysis, abandonment Analysis, Project control, Designing the control system, Scope creep and change control. Project Evaluation, Auditing and Project Termination.	**07**
	TOTAL	**45**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**25**	**15**	**10**	**10**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of Project Management directly contributes to

SDG 1	**No Poverty**
SDG 2	**Zero Hunger**
SDG 3	**Good Health and Well-being**
SDG 4	**Quality Education**
SDG 5	**Gender Equality**
SDG 6	**Clean Water and Sanitation**
SDG 7	**Affordable and Clean Energy**
SDG 8	**Decent Work and Economic Growth**
SDG 9	**Industry, Innovation and Infrastructure**
SDG 10	**Reduced Inequalities**
SDG 11	**Sustainable Cities and Communities**
SDG 12	**Responsible Consumption and Production**
SDG 13	**Climate Action**
SDG 14	**Life Below Water**
SDG 15	**Life on Land**
SDG 16	**Peace, Justice and Strong Institutions**
SDG 17	**Partnerships for the Goals**

Reference Books:

1. Project Management by Samuel J. Mantel, Jr., Jack R. Meredith, Scott M. Shafer, Margaret M. Sutton with M. R. Gopalan (WILEY-INDIA)
2. Project Management: A Managerial Approach, Meredith, J. R. and Mantel Jr., S. J., John Wiley, New York. 2004

3. Project Management and Appraisal by Sitangshu Khatua (Oxford)
4. Project Management for Business and technology: Principles and Practice, John M. Nicholas, Pearson Prentice Ha l, New Delhi, 2005.
5. A Guide to the Project management Body of Knowledge (PMBOK Guide) 5 th Edition, PMI.
6. Project Management-Case Studies, Harold Kerzner, John Wiley & Sons, New Jersey, 2006
7. Quantitative Methods in Project Management, Good pasture, J. C., J Ross Publishing, Boca Raton, Florida, USA.2003
8. Project Management: Engineering, Technology and Implementation, Shtub, A., Bard, J. F. and Globerson, S., Prentice Ha l, Englewood Cliffs, USA. 1994

Standards and Act:

1. IS/ISO 21500:2012 – Guidance on Project Management
2. IS 15656:2006 – Code of Practice for Project Management for Construction
3. IS/ISO 10006:2017 – Quality Management in Projects
4. ISO 21500, PMBOK: Fundamentals
5. IS 15656, CPWD Manual: Planning & Execution
6. ISO 9001, ISO 10006: Quality & Risk:
7. NITI Aayog & Finance Ministry guidelines: for Public Projects

List of Experiments:

1. Study and Analysis of Project Life Cycle and Characteristics in Contemporary Organizations.
2. Exercise on Selection and Formulation of Projects Aligned with Organizational Goals under Uncertainty.
3. Exercise on different project organizational structures.
4. Exercise to develop a WBS and integrate it with responsibility assignment.
5. Exercise to analyze the roles and responsibilities of a Project Manager (PM). (Study a real project case (industry or academic).)
6. Exercise to understand project planning and team dynamics.
7. Preparation and Analysis of Project Budget using Different Budgeting and Cost Estimation Methods.
8. Assessment of Budget Uncertainty and Application of Risk Management Techniques in Project Costing.
9. Exercise for Preparation of Gantt Chart and Milestone Chart for Project Scheduling.
10. Exercise for Development of Project Network using PERT/CPM Techniques with AON and AOA Representation and time calculation.
11. Exercise for Time Estimation and Probability Analysis for Project Completion using PERT.
12. Exercise for Resource Allocation, Levelling, and Project Crashing for Optimized Project Scheduling.
13. Exercise for Application of Earned Value Analysis (EVA) for Monitoring and Controlling Project Performance.
14. Exercise for Design and Implementation of Project Control System with Scope Change and Project Evaluation Techniques.

Major Equipment:

Nil

List of Open Source Software

1. Project Management software: for concepts like WBS, Gantt charts, PERT/CPM, resource allocation, etc.
2. Web base:
   a) OpenProject: Features: Gantt charts, Scrum boards, cost tracking, complete project lifecycle (planning to control)
   b) Freedcamp: Includes tasks, milestones, dashboards, Kanban boards, Easy for beginners
   c) Odoo: Supports portfolio management and collaboration

List of learning website:

1. http://nptel.ac.in/courses/

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	15h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	15h (need to be changed as per total PBL hours)	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	8h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, quality of report and demonstration
4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness of submitted assignment
7.	Group Discussion / Quiz / Simulation	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the

				certificate produced.
9.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster / Chart / PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1h – 3h per topic	Based on performance in group discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research laboratory visit	Expert lecture/session	Duration 3h For attending the lecture/session– 2h and for report writing 1h	Based on the proof of attendance and report submitted
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed

	/ Research Writing			and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report	Based on report quality and understanding of the relevant Indian Standard(s).

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Project Management compulsorily incorporates Micro Project and 5 marks as PBL activities.** These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Electronics and Communication Engineering and Allied Branches)
Subject Code: BE05000511
Subject Name: Computer Organization & Architecture

WEF Academic Year :	2024-25
Semester :	5
Category of the Course :	MOPEC-02

Course Outcome :

After Completion of the Course, Student will able to :

No	Course Outcomes	RBT Level*
01	Identify and explain the basic structure and functional units of a digital computer.	UN
02	Write assembly language programs and identify the role and working of various functional units of a computer for executing an instructions.	AP
03	Design processing unit using the concepts of ALU and control logic design.	AN
04	Design circuits for interfacing memory and I/O with processor.	CR
05	Comprehend the features and performance parameters of different types of computer architectures.	CR

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Practical			
L	T	P	PBL*	TH	TH/30	ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	0	0	15	60	2	70	30	00	30	00	130

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content :

Sr. No.	Content	Total Hrs
1	Computer Data Representation : Basic computer data types, Complements, Fixed point representation, Register Transfer and Micro-operations: Floating point representation, Register Transfer language, Register Transfer, Bus and Memory Transfers (Tree-State Bus Buffers, Memory Transfer), Arithmetic Micro Operations, Logic Micro-Operations, Shift Micro-Operations, Arithmetic logical shift unit	5
2	Basic Computer Organization and Design Instruction codes, Computer registers, computer instructions, Timing and Control, Instruction cycle, Memory-Reference Instructions, Input-output and interrupt, Complete computer description, Design of Basic computer, Design of Accumulator Unit.	4
3	Assembly Language Programming Introduction, Machine Language, Assembly Language Programming: Arithmetic and logic operations, looping constructs, Subroutines, I-O Programming.	6
4	Micro programmed Control Organization: Control Memory, Address sequencing, Micro program example, Design of Control Unit	4
5	Central Processing Unit Introduction, General Register Organization, Stack Organization, Instruction format, Addressing Modes, Data transfer and manipulation, Program control, Reduced Instruction Set Computer (RISC) & Complex Instruction Set Computer (CISC)	5
6	Pipeline And Vector Processing Flynn's taxonomy, Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction, Pipeline, RISC Pipeline, Vector Processing, Array Processors	5
7	Computer Arithmetic Introduction, Addition and subtraction, Multiplication Algorithms (Booth Multiplication Algorithm), Division Algorithms, Floating Point Arithmetic operations, Decimal Arithmetic Unit.	5
8	Input-Output Organization Input-Output Interface, Asynchronous Data Transfer, Modes Of Transfer, Priority Interrupt, DMA, Input-Output Processor (IOP), CPUIOP Communication, Serial communication.	5
9	Memory Organization Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory.	6

This syllabus is mapped with following United Nation's Sustainable Development Goals:

SDG 4 - Quality Education.
SDG 8 - Decent Work and Economic Growth,
SDG 9 - Industry, Innovation and Infrastructure,
SDG 12 - Responsible Consumption and Production,
SDG 13 -Climate Action

Relevant BIS standards:

IS 13252 (Part 1) – Safety of Information Technology Equipment
IS/IEC 60950-1 – IT Equipment Safety
IS/IEC 62368-1 – Audio/Video, IT & Communication Equipment Safety
IS 14700 Series – Electromagnetic Compatibility (EMC)
IS/IEC 61000 Series – EMC Standards
IS 16603 – Data Center Infrastructure Requirements
Also explore other relevant Indian and international standards.

Reference Book :

1. M. Morris Mano, "Computer System Architecture", Pearson Education
2. Yale N. Patt, Sanjay J. Patel, "Introduction to Computing Systems" McGraw Hill.
3. Hamacher, Vranesic, Zaky, "Computer Organization", McGraw Hill.
4. Andrew S. Tanenbaum and Todd Austin, "Structured Computer Organization", Pearson Education
5. N. D. Jotwani, "Computer system organization", McGraw Hill
6. R.S.Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085A", Penram International
7. Douglas Hall, Microprocessors and Interfacing, TMH.

Activities suggested under Self-learning/Team Work:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.

3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/ health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.

13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Textile Technology
Subject Code: BE05000521
Subject Name: Sustainability and Circularity in Textile Industry

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC-02

Prerequisite:	Basic knowledge of chemistry
Rationale:	The objective of this course is to give a glimpse of sustainability-related issues and initiatives related to the textile and apparel industry. The course aims to apprise the students about the importance of various resources used in textile manufacturing and the ways to reduce the consumption of these resources. The various standards and certifications related to sustainability are also covered.

Course Outcomes:

No	CO statement	RBT Level
01	Understand the concepts of sustainability and circularity	U, A, N, C
02	Analyze different frameworks of sustainability and circularity	R, U, A
03	Evaluate different sustainable processes and practices adopted in the textile industry	R, U, A
04	Understand the life cycle analysis of textile products	U, A, N
05	Understand different standards and regulations related to sustainability	U, N, E

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	TW/ SL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	TW/ SL (I)	ESE (V)	
30	0	30	0	60	2	70	30	20	0	30	150

Content:

Sr. No.	Content	Total Hrs	% of Weightage

1	Defining sustainability and circularity, three dimensions of sustainability, sustainable development goals, Net zero.	**2**	**5**
2	Environmental impacts of textile and fashion industry, resource consumption (water, energy etc.) in fibre production, yarn manufacturing, fabric manufacturing, and chemical processing; Types of emissions, scopes I, II and III, measuring carbon footprints, decarbonizing textile supply chain.	**6**	**13**
3	Traceability, the need for traceability in the textile value chain, use of blockchain and fibre tags/coins for traceability	**3**	**6**
4	Sustainable textile processes, restricted substances for textile and clothing industry; Concepts of green chemistry, natural dyeing, supercritical carbon dioxide, ozone, UV and plasma technologies, foam dyeing, dope dyed fibres; Renewable energy sources, solar, hydro, wind,etc.	**6**	**13**
5	Effluent treatment, primary, secondary and tertiary treatments, zero liquid discharge (ZLD), rotary evaporators, idea of cost and capacity of ZLD plants; Standards of BOD, COD, TDS, TSS, pH, and heavy metals.	**5**	**11**
6	Circularity, circular design, 3Rs (reduce, reuse and recycle), RESOLVE framework, restoration and regeneration; Textile recycling, upcycling, and downcycling, open-loop and close-loop recycling, sorting technology; Methods of recycling, mechanical, thermal and chemical recycling, recycling of pre and post-consumer textiles, challenges.	**7**	**15**
7	Life cycle analysis, cradle-to-gate, cradle-to-grave, and cradle-to-cradle approaches, cut-off and allocation approaches, system boundary; Steps of LCA, unit of analysis, inventory assessment, impact assessment, and interpretation; Case studies related to LCA analysis of textile products.	**9**	**22**
8	Standards and certifications, needs, ISO 14000, Oeko-tex 100, Higg-index, GOTS, SMETA members ethical trade audit (SEDEX), Global Recycled Standard (GRS).	**5**	**11**
9	Environmental, social and governance (ESG) factors, social sustainability, issues in textile and fashion industry, governance mechanisms	**2**	**4**
	TOTAL	**45**	**100**

Suggested Specification table with Marks (Theory):(For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	**30**	**15**	**10**	**10**	**10**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Sustainable Textiles: Life Cycle and Environmental Impact by R. Blackburn, Woodhead Publishing Series, 2009.
2. Roadmap to Sustainable Textiles and Clothing: Eco-friendly Raw Materials,
3. Technologies, and Processing Methods edited by S. S. Muthu, Springer, 2014.
4. Roadmap to Sustainable Textiles and Clothing: Environmental and Social Aspects of Textiles and Clothing Supply Chain edited by S. S. Muthu, Springer, 2014.
5. Roadmap to Sustainable Textiles and Clothing: Regulatory Aspects and Sustainability Standards of Textiles and the Clothing Supply Chain edited by S. S. Muthu, Springer, 2015.

(b)source software and website:

1. Web sites of textile testing instrument manufacturers, namely Uster, SDL etc., BIS, BS, ASTM and other standard methods of textile testing.
2. http://nptel.iitm.ac.in, World Wide Web, Google Search Engine etc.

Suggested Activities for Students:

1. Visit to textile mill and preparing report

Overall SDG Mapping

This course on Sustainability and Circularity in Textile Industry supports United Nations **SDG 6, SDG 7, SDG 8, SDG 9, SDG 12, and SDG 13** by providing students with the tools to reduce resource consumption, implement circular design, and ensure ethical governance. It prepares graduates to lead the textile industry's transition toward carbon neutrality and zero-waste manufacturing through technical innovation and rigorous sustainability standards.

List of suggested activities for Term Work / Self Learning:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data
2	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.

3	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
4	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
5	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
7	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/ any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
8	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
9	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.

- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: UG

Branch: Textile Technology

Subject Code: BE05000531

Subject Name: Textile for Engineering Application

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC-02

Prerequisite:	Students should have knowledge of basics of textile fibres and yarn manufacturing, fabric manufacturing techniques, basic mechanics and polymer science.
Rationale:	Textiles are no longer limited to conventional apparel applications. Modern engineering applications require textiles in medical, automotive, composites and industrial application. This subject provides an understanding of textile materials as engineering materials, focusing on structure, property and performance relationships and advanced functional applications.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Classify various fibers, yarn and fabric use as engineering materials.	R, U
02	Classify technical textiles based on their functional requirements and diverse industrial application areas.	R, U
03	Select appropriate textiles material for medical and automotive textile	A, N, E
04	Analyze the synergistic role of matrix and reinforcement in textile composites to determine their suitability for specialized engineering applications.	U, A, N
05	Identify specialized textiles for geotextile, agricultural, industrial and packaging application.	R, U, A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	TW/ SL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	TW/ SL (I)	ESE (V)	
45	0	0	15	60	2	70	30	20	30	0	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Fiber, Yarn, and Fabric Structures Use for various engineering applications - Natural Fibers, Synthetic Fibers, High-Performance Fibers, type of Yarn, Fabric Structure -Woven, Knitted, Braided and Nonwoven	10	22
2.	Technical Textile – Introduction, Definition and scope for technical textiles, Classification of technical textiles, Present market scenario of technical textiles.	6	13
3.	Medical textiles - Classification, Specialty fibres used in manufacturing, Processes, Essential properties and Applications.	8	18
4.	Automotive textile - applications for vehicles like trims, seat belts, air bags, filters, separators, liners, tyres, hoses etc., applications in marine and aviation.	8	18
5.	Textile Composites - Definition, classification of composites, function of the matrix and reinforcement in composites, advantages & disadvantages of composites, properties of composites, application of composites structural components, ballistic, aerospace, automotive, medical, sporting goods, marine, infrastructure etc.	8	18
6.	Application of textile in packing, agriculture, Geotextiles, Textiles in Ropes	5	11
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	30	25	15	5	5

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Handbook of Technical Textiles – A. R. Horrocks & S. C. Anand
2. High Performance Fibres – J. W. S. Hearle
3. Textile Materials – W. E. Morton & J. W. S. Hearle

4. Principles of Woven Fabric Manufacturing – Abhijit Majumdar
5. Handbook of Industrial Textiles – Sabit Adanur
6. R. Senthil Kumar, "Textiles for Industrial Applications", CRC Press, 2014.

(b) Open source software and website:

1. https://nptel.ac.in
2. World Wide Web, Google Search Engine etc.

Suggested Course Practical List:

List of Laboratory/Learning Resources Required:

Suggested Project List:

Suggested Activities for Students:

1. Industry visit
2. Assignment on material selection
3. Case study on application of textile in various industry
4. Online course - NPTEL

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Electrical Engineering and Allied Branches)
Subject Code: BE05000541
Subject Name: Fundamentals of Power Electronics

w.e.f.Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC

Prerequisite:	Basic knowledge of Electrical and Electronics Engineering
Rationale:	The syllabus of Fundamentals of Power Electronics introduces non- circuit branch students to the basic concepts and role of Power Electronics in the present industrial scenario. Power Electronics enables efficient conversion, control, and conditioning of electric power using semiconductor devices. It underpins renewable energy systems, electric vehicles, consumer electronics, power supplies, robotics, automation, and smart grids. For non–power-electronics engineering students, this course builds the essential conceptual foundation required to understand how power converters function and are applied in real-world systems, strengthening interdisciplinary skills for modern technology and automated manufacturing processes.

Course Outcomes:

Sr.No.	CO statement	Marks% weightage
CO-1	Explain the fundamental concepts, scope, applications, and classifications of power electronics systems.	15
CO-2	Describe characteristics, construction, and working principles of power semiconductor devices and passive components.	15
CO-3	Analyze the operation of rectifier circuits with different loads and switching devices.	20
CO-4	Illustrate the working principles, types, and applications of inverter circuits.	20
CO-5	Explain the topology, operation, and applications of DC–DC and AC–AC converters.	30

Teaching and ExaminationScheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL *	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	0	0	15	60	2	70	30	00	30	0	130

**** Problem-Based Learning (PBL) aims to accommodate learning beyond the syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End Semester Examination, PA = Progressive Assessment.

Content:

Sr.No.	Content	Total Hrs
1	**Introduction to Power Electronics & Power Semiconductor Devices:** Basics of Power Electronics, Power Electronics Systems, applications, control vs power circuits.Device classification: Diodes, SCR, TRIAC, DIAC, BJT, MOSFET, IGBT, Device structure & operation (conceptual)- Ratings, switching frequency, thermal considerations.	8
2	**Other Components in Power Electronics**: Passive components: Resistors: types, ratings, roles, Inductors: types, filtering, energy storage, Capacitors: ESR, ripple, filtering, snubbers, Transformers: isolation, pulse transformers. Protective components like MOV, Fuse, Thermistor, etc., their construction, working and applications.	5
3	**Power Rectifiers** Diode rectifiers: half/full wave, bridge., Controlled rectifiers: half / fully controlled, firing angle, Effect of R, RL loads, Applications of Power Rectifiers like power supplies, battery charging etc.	8
4	**Inverters** Need for DC–AC conversion, inverter types, VSI and CSI: square wave inverter, Introductory PWM, 3-phase inverter basics, Applications of inverters like UPS, EV drives, solar inverters, industrial motor drives etc.	8
5	**DC–DC Converters:** DC Power supply basics, Linear power supply, Concept of switching power supply, Duty cycle and switching principles, Buck, Boost, Buck–Boost converters, Flyback and Forward converter basics, isolated and non-isolated power supply, Applications: SMPS, EV subsystems, battery chargers, industrial power supply etc.	10
6	**AC–AC Converters** Need for AC voltage/frequency control, AC voltage controllers, phase control, Cycloconverters, Applications: light dimmers, fan regulators, soft starters.	6
	TOTAL	45

Suggested Specification table withMarks(Theory):(ForB.E.only)

Distribution of Theory Marks					
RLevel	ULevel	ALevel	NLevel	ELevel	CLevel
30	**25**	**20**	**15**	**10**	**==**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate; C: Create and above Levels (Revised Bloom's Taxonomy)

Note:This specification table shall be treated as a general guideline for students and teachers.Theactual distribution of marks in the question paper may vary slightly from the above table.

The Fundamentals of Power Electronics syllabus has a direct alignment with SDGs 7 (Affordable and Clean Energy), 9 (Industry, Innovation and Infrastructure), and 13 (Climate Action), and contributes indirectly to SDGs 8, 11, and 12.

SDG 7	Affordable and Clean Energy— Direct Alignment Topics like inverters, DC–DC converters, and rectifiers enable efficient energy conversion in solar systems, EV drives, and battery charging, making clean energy usable and cost-effective.
SDG 8	Decent Work and Economic Growth — Indirect Alignment Use of **power electronics in industrial drives, EV systems, and power supplies** enhances productivity and supports growth in emerging energy and electronics sectors.
SDG 9	Industry, Innovation, and Infrastructure — Direct Alignment Study of power semiconductor devices (IGBT, MOSFET, SCR) and converters (AC–AC, DC–DC) supports industrial automation, motor drives, and modern electrical infrastructure development.
SDG 11	Sustainable Cities and Communities — Indirect Alignment Applications of inverters (UPS), AC voltage controllers, and DC–DC converters improve energy
SDG 12	Responsible Consumption and Production — Indirect Alignment Concepts like device ratings, thermal management, and passive/protective components promote efficient design, reduced energy waste, and longer equipment lifespan.
SDG 13	Climate Action — Direct Alignment Efficient operation of switching devices and converters reduces energy losses and supports renewable energy integration and EV systems, directly lowering carbon emissions.

ReferenceBooks:

1. Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education, New Delhi
2. Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics: Converters, Applications and Design, John Wiley & Sons, Inc., New York
3. L Umanand, Power Electronics, Essentials & Applications, Wiley India
4. B. K. Bose, *Power Electronics and Motor Drives: Advances and Trends*, Academic Press (an imprint of Elsevier), Waltham, MA.
5. P. S. Bhimra, "*Power Electronics*", Khanna Publishers
6. Research Papers on IEEE/IET/Science Direct etc

List of Experiments: NA
Major Equipment: NA
List of Open-SourceSoftware:

1. Scilab (https://www.scilab.org/) – An open-source alternative to MATLAB
2. PSIM (Free Version) / OpenModelica (https://openmodelica.org/) – For modelling and simulating power electronics circuits

List of learning websites:

1. MIT OpenCourseWare (https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/)
2. CircuitLab (Free with limited access) (https://www.circuitlab.com/) – Web-based circuit

simulator

3. Virtual Labs by IITs (Government of India Initiative) (https://vlab.co.in/) – Simulations and experiments related to Power electronics.
4. Reputed Research Journal Website

Listofsuggested activities for Problem-based Learning (PBL):

Sr. No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Industry/Research laboratory Visit (Power converters/electronics/drives company)	Visit = 5hrs, Report preparation = 5hrs Total = 10hrs	Based on the report submitted. The report should contain observations and calculations based on industry/ lab data.
2	Video-Based Learning	Technical Video-based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5hrs Report preparation = 5hrs Total = 10hrs	Report /presentation based on the video learning outcomes.
		Self-learning online course	Minimum duration of the course should be 10 hours.	Examination-based assessment at the end of the course. Based on the certificate produced.
		Annotated Video Explanation of Concept/Problem	10hrs (Preparation + Recording + Submission)	Based on the accuracy of explanation, clarity, and presentation style.
3	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical-based assignment is preferable.	5 assignments of 2 hours each. Total = 10hrs	Based on the assignment submitted.
		Blog or Technical Article Writing	10hrs (Research – 6hrs, Writing – 4hrs)	Based on originality, technical content, references cited, and clarity of communication.
4	Complex Problem-Solvingtargeting relevant SDGs.	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total = 15 hrs	Based on the depth of the solution submitted.
5	Research Paper Review / Analysis	Discussion on a research paper based on a relevant subject (SCOPUS Index/any reputed Journal)	5 research paper = 20 hrs	Summarize research paper and the evaluation of critical parameters
6	Poster/ Chart/PowerPoint presentation	Poster/chart/PowerPoint preparation on technical topics	Duration = 6 hrs	Based on poster/chart preparation and presentation skills
7	MicroProject	Working/non-working model on technical topics	Working = 10hrsnon-working = 10hrs	Based on inter-department/external evaluation
8	Group Discussion /	Group Discussion on emerging/trending	Duration = 1 hrs each	Based on performance in group discussion, technical

Sr. No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
	Quiz / Simulation	technical topics based on the subject		depth,knowledge etc.
		Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10 hours	Based on quiz scores and the reflection report after each quiz.
9	Case Study Analysis / Seminar	Real-world case studies-based learning	Duration of data collection/study = 5hrs Report preparation = 5hrs Total = 10hrs	Based on an in-depth study, technical depth, data collected, fact-finding, etc.
10	Other	Patent Search and Innovation Gap Identification	10hrs (Search + Report)	Based on the number of relevant patents analyzed and the identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Fundamentals of Power Electronics** incorporates various activities as integralProblem-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Chemical Engineering and Allied Branches)
Subject Code: BE05000561
Subject Name: Sustainable Energy Technology

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC-Mandatory Open Elective Courses

Prerequisite:	Basic knowledge of physics, mathematics and thermodynamics
Rationale:	Rapid depletion of fossil fuels and climate change concerns necessitate sustainable energy solutions. This course introduces energy sustainability concepts, SDGs, conventional and renewable energy sources, emerging technologies, energy management, and modern trends aligned with the latest technology.

Course Outcome:

After completion of the course, student will able to:

No	Course Outcomes
01	Explain sustainability concepts, role of energy and energy-related SDGs.
02	Understand conventional energy sources and their applications.
03	Understand non-conventional/renewable energy sources and their applications.
04	Evaluate emerging technologies for energy generation.
05	Apply energy management and conservation techniques.

Teaching and Examination Scheme:

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Practical			
L	T	P	PBL*	TH	TH/30	ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	0	00	15	60	2	70	30	0	30	0	130

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction:** Global energy scenario and sustainability challenges, limitations of conventional energy sources, need for clean and renewable energy technologies, emerging energy generation technologies, role of energy storage and conversion systems, energy transition, decarbonization, and net-zero targets, importance of sustainable energy in economic development, United Nations Sustainable Development Goals (SDGs), Affordable and Clean Energy (SDG 7), energy policies supporting SDG.	**7**	**15**

2.	**Energy generation sources:** **Conventional energy sources:** Fossil fuels: properties, extraction, utilization, and environmental impacts; Thermal power plants – working principle, efficiency, environment impact; Nuclear energy: basic principle, types of reactors, advantages and limitations. **Non-Conventional / Renewable energy sources:** Solar energy: solar radiation, solar thermal systems, photovoltaic systems, applications; Wind energy: wind energy conversion systems, wind turbines, onshore and offshore wind farms; Biomass energy: biogas plants, biofuels, waste-to-energy concept; Other renewable sources: hydropower, geothermal and ocean energy; Advantages and limitations of renewable energy sources.	**10**	**25**
3.	**Emerging Technologies for energy generation:** **Hydrogen energy**: fundamentals, hydrogen as an energy carrier, advantages and limitations of hydrogen energy, safety, storage, and transportation of hydrogen; Green hydrogen – concept, significance, grey, blue, and green hydrogen; Hydrogen production methods – Conventional techniques: Steam Methane Reforming, coal gasification, partial oxidation and autothermal reforming, Renewable and low-carbon hydrogen production: water electrolysis, biomass gasification, photo electrochemical water splitting, biological methods; **Electrolyzer Technologies**: Introduction, working principle, types of eletrolyzers, advantages and limitations. **Fuel cell technology**: Concept of fuel cell, working principle, component of fuel cell, comparison of fuel cells with batteries and IC engines, different types of fuel cell, fuel-cell electric vehicle, advantages and limitations.	**10**	**25**
4.	**Energy generation from waste:** Concept and importance of energy recovery from waste, sources of waste, environmental aspects; Thermal Conversion Technologies-incineration, pyrolysis, gasification, comparison of the thermal conversion technologies; Biological Conversion Technologies- Anaerobic digestion, biogas generation, Landfill gas recovery, fermentation processes for bioenergy; Refuse-Derived Fuel (RDF) and Co-processing – RDF preparation and quality parameters, co-processing of waste in cement kilns and boilers; Waste heat recovery, waste heat recovery methods and devices, economic benefits.	**10**	**20**
5.	**Energy management and conservation:** Introduction, energy management systems (EMS), Energy regulations and standards, ISO 50001, 50002, energy conservation techniques in industry, economic analysis of conservation measures; Energy audit - introduction, role of energy audit in sustainable development, Types of energy audit, steps involved in energy audit, instruments used, report preparation, case study.	**8**	**15**
	Total	**45**	**100**

Overall Course SDG Mapping:

The course as a whole primarily addresses **SDG 7: Affordable and Clean Energy**, **SDG 9: Industry, Innovation and Infrastructure**, **SDG 11: Sustainable Cities and Communities, SDG 12: Responsible Consumption and Production**, and **SDG 13: Climate Action** through comprehensive coverage of emerging clean energy technologies and climate mitigation strategies.

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**25**	**15**	**10**	**10**	**---**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

References/Suggested Learning Resources:

(a) Books:

1. B. H. Khan, Non-Conventional Energy Resources, McGraw Hill Education.
2. S. Rao and B. B. Parulekar, Energy Technology, Khanna Publishers.
3. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers
4. General aspects of energy management and energy audit, Bureau of Energy Efficiency, 4th ed. 2015.
5. D.P.Kothari, K.C.Singal, R. Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Pub.

(b) Open source software and website:

1. Students can refer to video lectures available on the websites including NPTEL.
2. Students can refer to the website (www.beeindia.gov.in) for energy management and audit.

List of suggested activities for Problem based Learning:

Sl. No.	Activity	No. of hours	Total hours claimed	Evaluation criteria
1	Assignments on topics based on sustainable energy technology	Five assignments (2h each)	**10**	Quality of submitted assignment.
2	Literature Review: Review 3–5 research papers on non-renewable energy, energy management, emerging technologies and other related topics and prepare a report.	Literature review: 5h Report preparation: 5h	**10**	Relevance of papers, depth of research papers reviewed, technical analysis, Quality of report.
3	Developing posters, charts or PowerPoint presentations on topics related to emerging sustainable technologies.	Study and in-depth analysis of content: 4h Preparation and presentation of visual content: 1h	**5**	Quality of topic researched and presentation.
4	Technical video based learning related to subject and report preparation.	Duration of video: 4h, report preparation: 1h.	**5**	Quality of technical video based learning and report prepared.

5	Energy audit of an industry.	Energy audit report	**10**	Quality of the energy audit work and report submitted.
6	Self-learning on-line course.	Min. Duration of the course should be 10h	**10**	On submission of certificate of completion.
7	Development of physical model	Model development: working 10h, non-working 5h	**5/10**	Quality of model developed and explanation.
8	Industry visit	Industry visit: 5h, Report preparation: 5h	**10**	Quality of observations made and detail report submitted.
9	Case study	Data collection, case analysis: 5h Report preparation: 5h	**10**	Understanding and analysis of the selected case and report submitted.

- Above activities are suggestive, faculty can choose any of these activities.
- The number of hour is suggestive. Faculty can sub-divide the number of hours based on the activity. However, the total number of hours is fixed.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record keeping and to ensure transparency in the evaluation and assessment of problem based learning.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Under Graduate

Branch: ALL (Except Chemical Engineering and Allied Branches)

Subject Code: BE05000571

Subject Name : Sustainable Polymers: Materials, Safety and Circular Economy

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC-02

Prerequisite:	None
Rationale:	This course provides the knowledge of Polymers — rubber, plastics, fibres, and coatings — are the core materials of every engineering industry, yet most programmes offer little structured exposure to their science, processing, safety, or sustainability, leaving graduates underprepared for industrial realities. This course fills that gap through six purposefully sequenced units covering polymer science fundamentals, rubber and plastics technology, processing defects and troubleshooting, chemical hazard management, and circular economy principles. The inclusion of processing defects and troubleshooting directly addresses a practical industry need — defects such as short shots, sink marks, melt fracture, and porosity cause significant production losses daily. The safety unit ensures students can read SDS documents, select appropriate PPE, and apply engineering controls before entering the workplace. The final unit aligns students with the growing regulatory and sustainability demands of the polymer industry, including India's Plastic Waste Management Rules, REACH, and ZDHC compliance. The course is intentionally designed as a multidisciplinary professional elective, equally relevant to students from rubber, plastics, textile, chemical, and mechanical engineering backgrounds, preparing them to work with polymeric materials knowledgeably, safely, and responsibly.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	Marks % weightage
C01	Classify and explain polymer types, polymerization methods, and key properties relevant to rubber, plastic, and fibre industries.	20
C02	Describe the science, processing, and industrial applications of natural and synthetic rubbers including rubber-fabric composite products.	20
C03	Identify major plastics by properties and processing methods and explain the role of additives in product performance.	20
C04	Analyse common processing defects in rubber and plastics manufacturing and recommend corrective actions using systematic troubleshooting tools.	20
C05	Evaluate chemical hazards, apply safety measures, and assess circular economy strategies and regulatory frameworks governing polymer materials.	20

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Under Graduate

Branch: ALL (Except Chemical Engineering and Allied Branches)

Subject Code: BE05000571

Subject Name : Sustainable Polymers: Materials, Safety and Circular Economy

Teaching and Examination Scheme:

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Practical			
L	T	P	PBL*	TH	TH/30	ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	00	00	15	60	2	70	30	30	0	0	130

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Foundation: Polymer Science Essentials:** Introduction to Polymers, Classification of Polymers, Polymerization — How Polymers Are Made, Key Polymer Properties.	08	15
2.	**Rubber: Science, Technology and Applications:** Natural Rubber, Vulcanization, Rubber Compounding, Synthetic Rubbers — Types and Properties, Rubber Processing Methods, Rubber + Fabric Composite Products.	07	15
3.	**Plastics: Science, Technology and Applications:** Introduction to Plastics, Major Thermoplastics — Properties and Applications, Thermosets and Elastomeric Plastics, Plastic Processing Methods, Plastic Additives.	07	15
4.	**Polymer Processing Defects & Troubleshooting:** Introduction to Defects in Polymer Processing, Defects in Rubber Processing & Moulding, Defects in Plastics Processing, Coating & Moulding, Quality Control Tools & Defect Prevention.	07	15
5.	**Material Safety and Industrial Hazard Management:** Fundamentals of Industrial Hazard and Risk, Chemical Hazards in Rubber Processing, Chemical Hazards in Plastics Processing, Safety Data Sheet (SDS) — Practical Reading, Personal Protective Equipment (PPE), Engineering Controls and Ventilation.	08	20
6.	**Circular Economy, Regulations and Sustainable Polymers:** Linear Economy vs. Circular Economy, Polymer Waste and Recycling, Extended Producer Responsibility (EPR) and Life Cycle Assessment (LCA), Bio-Based and Biodegradable Polymers, Regulatory Framework.	08	20
	Total	45	**100**

Suggested Specification Table with Marks (Theory):

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Reference Books:

1. Introduction to Polymer Science and Technology by H.R. Billmeyer Jr.
2. Rubber Technology by Maurice Morton
3. Plastics Technology Handbook by Manas Chanda & S.K. Roy
4. Industrial Safety Management by L.M. Deshmukh
5. Circular Economy: A Handbook for Business and Supply Chains by C. Webster & C. MacArthur
6. Bioplastics for Sustainable Development by Luc Avérous (Ed.)

(b) List of Open Source Software/learning website:

- **https://ocw.mit.edu/**
- **https://onlinecourses.nptel.ac.in/e-learning**
- **https://chem.libretexts.org/**

Overall SDG Mapping

The course on Polymer Science, Rubber and Plastics Technology, Processing Defects, Industrial Safety, and Sustainable Polymers supports United Nations **SDG 3, SDG 4, SDG 8, SDG 9, SDG 12, and SDG 13** by promoting scientific knowledge, industrial innovation, safe manufacturing practices, quality improvement, waste reduction, recycling, circular economy concepts, and sustainable polymer technologies. It prepares students to address industrial, environmental, and sustainability challenges in the polymer and rubber industries.

Activities suggested under problem based learning:

Sr No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Online Course	Minimum duration of the course should be 20 h.	Based on assignment submitted and certificate produced.
2.	Virtual /Industry Trip	Duration of hours-5h Report preparation- 5h Total -10 h	Based on report submitted. Report should contain manufacturing process, flow chart.
3.	Assignments	Completion of five independent tasks, each	Based on assignment submitted.

		designed for a 3-hour engagement. Total = 15h	
4.	Case Study Analysis related to subject	Duration of data collection -6 h Report preparation – 4h Total- 10 h	Based on Problem identification, depth of analysis, technical insight, application relevance
5.	Technical Article/Video Reviews related to subject	Duration of Review -6h Report preparation -4h Total-10h	Relevance of content, clarity of summary, insights drawn, conceptual understanding
6.	DIY Experiments	5 hours including report preparation	Based on report submitted. Report should contain experiments performed which have Creativity, relevance to rubber properties, observation documentation, safety awareness.
7.	Course Seminar	Duration -10h	Based on technical Content & Understanding, Analysis, literature review, Quality of report and presentation.
8.	Mini/ Micro Project	Duration -10h	Based on Technical Analysis, literature review, methodology, innovation/sustainability aspect, Quality of report and presentation.
9.	Complex Problem solving	Duration -5h	Evaluation is based on problem complexity & clarity, analytical approach, design/experimental methodology, use of modern tools, sustainability considerations, innovation, result validation, and feasibility of solution.
10.	Videos focusing on industrial safety topics relevant to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based report submitted. Report should contain all safety aspects explaining its importance.
11.	Visual presentation of technical content through posters, charts, or PowerPoint slides	Duration = 10 h	Based on quality of poster/chart preparation, creativity, accuracy and effectiveness of presentation skills.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Course Abstract for

DESIGN ENGINEERING – II B

(6th Semester)

Course initiated by:

Centre for Industrial Design

(OPEN DESIGN SCHOOL)

For any query, please write us at : design@gtu.edu.in

Design Engineering – II B (3160001) (6th Semester)

Module 2: Building The Solution

Name of the Discipline & the Programme: **Every discipline of the Engineering**

Usual time of occurrence: **6th Semester**

Duration: **Six (6) months**

Course category: **Core Advance**

Credits: **03**

Examination Pattern: **External Practical/Viva exam at the end of semester**

Prerequisites: **Design Engineering – 1A, Design Engineering – 1B, Design Engineering – 2A**

Relevance: This is an advance level course designed for those who have undergone the fundamentals of Design Thinking process and understand the importance and process completely.

Objective: Understanding Design Thinking: The course aims to validate the learnings from the understanding Design Thinking course by translating the concepts into exercises. In this module, student will continue their work from 5th semester on Community based project and complete the Design Thinking cycle with emphasis on product development, detail design, prototyping and validation of the solutions in real environment.

Course Contents: Students have started community-based projects and successfully gone through the process of Observation, Empathy, Ideation and initial stages of Product Development in 5th semester. Now in 6th semester, they will continue their work from concept to product development, detail design, prototyping and validation of the solutions in real environment. All students' team need to work towards final prototype and then test it in real environment. Final working model with YouTube video link is required for this module.

In 6th semester, students will consider various design considerations as described further in this document for detail design and then first prepare their models in software if required and then use prototyping techniques to further build the concepts. The content is divided into week-wise activities to better understand the course and to give enough time to all the learning aspects, but depending upon the type and nature of projects, students and guide may re-schedule the activities. Students in 6th semester need to follow below week-wise activities to complete the course requirement for 6th semester.

Design Thinking Process – with Tools & Techniques			
Module 4: DE-2B Building the Solutions			
Broad segment	**Week**	**Description**	**Operational need**
System level Design	1	• Plan of Action in 6th semester ➢ Based on revalidation, feedback from last semester (5th semester) plan for future aspects	• Discussion with faculty guide and modification based on feedbacks
Detailed Design	2, 3, 4	• Detailed Design (including all aspects of products, material, process, resources, standards etc.)	• Brief lecture/exercise • Very minute details of the concept will be considered • Prototyping techniques may be used to iterate
CAD Modelling & Analysis	5, 6, 7	• CAD Modelling & Analysis (Branch specific software will be used depending on projects)	• Software saves on time, money, resources etc. • Branch specific software must be provided by the college for students to use for their projects
Building the solutions	8, 9, 10, 11	• Prototyping (sequential prototyping for iterations) • Customer Revalidation • Modification • Iterate, Iterate, Iterate…..	• Prototype does not mean final product or working model but it is the process/phase to reach up to final product
Final Prototype	12	• Final working model should be prepared (The projects that involve higher cost and limitations on technology should be allowed other ways of prototyping other than working model)	• YouTube link of final working model is required for full mark
Project Fair	13	• Open project showcase/fair for showing the projects for Students, faculty members, local people and industrialists	• This fair should be open for all in surrounding area of college • It is compulsory to organize DE project fair
Feedback & Final Report	14	• Upload duly signed Continuous Assessment Card • Feedback, Online certificate generation through DE portal • Final Report	• As per the feedback received from Users/Stakeholders/other student groups/guide, student teams need to modify their design and further action plan. • Report writing should be continuous activity throughout the semester

In the 6th semester, student's team will validate their concept and detailed design part with reference to (1) Design for performance, safety and reliability, (2) Design for Ergonomics and Aesthetics, (3) Design for Manufacturing & Assembly (DFMA), (4) Design for cost & Environment, (5) Modelling and Analysis of their design (6) Prototyping (7) Engineering Economics of Design, (8) Design for Use, Reuse and Sustainability and (9) Test the prototype. And additionally, students will also learn topic like (10) Ethics in Design.

Following aspects should be taken into account while developing product.

1. **Design for Performance, Safety and Reliability:**

- Design for performance: The final product/process must perform for designed (projected in Product Development Canvas - PDC) features and functions as per the requirement of the user in actual working environment (revealed through rough prototype validation).
- Design for Safety: Safety is the most important aspect of human centric product/process. Reasonable factor of safety should be taken into account considering all adverse and factual factors (Ideation canvas – location/context/situation may be referred back here) as there is human interaction with product/process in manifold circumstances.
- Design for Reliability: Reliability is the ability of a system or component to perform its required functions under stated conditions for a specified period of time1 . Your final product/process should be reliable as required by the user and should perform its desired functions as required for desired time period.

2. **Design for Ergonomics and Aesthetics:**

- Ergonomics is all about designing for human factors/comforts wherever they interact with product/process and surrounding environments. According to the **International Ergonomics Association** within the discipline of ergonomics there exist domains of specialization:

  (a) Physical Ergonomics – is concerned with the human anatomy, bio mechanical and physiological ability and its relevance to the product and surrounding systems;
  (b) Cognitive Ergonomics – is concerned with the mental ability such as perception, memory, reasoning and response power as they affect the interactions between humans and products/systems;
  (c) Organizational Ergonomics – is concerned with the optimization of socio-technical systems including organizational structures, policies and processes

- Aesthetics is all about designing for physical appearance (looks) of the product. In current time, customers are willing to buy the products which have stunning looks with respect to their competitive products. Design for Aesthetics includes appearance, style, colour, form/shape, visuals and so on.

3. **Design for Manufacturability & Assembly (DFMA):**

DFMA stands for two terms; DFM – Design for Manufacturability which means for ease of manufacturing of parts/components of final product. DFA – Design for Assembly which means manufactured parts can be easily assembled to form a final product. DFMA approach helps to design and manufacture/construct the product easily and economically. Designer must design

components/parts that can be easily manufactured with available resources at minimum cost of production and can be easily assembled by assembly personnel. The intentions behind implementing DFMA practice in product development is to minimize manufacturing and assembly cost, improve efficiency, eliminate waste of material and time. Iteration on involved raw materials may be performed to check available alternatives – as materials play a major role in production cost. Basic guidelines may be followed as below:

♣ Check for alternative and compatible raw materials (Refer/ revise to LNM)
♣ Minimize the number of parts (Refer/ revise to PDC)
♣ Develop a modular design
♣ Design parts to be multi-functional
♣ Design parts for multiple-use
♣ Design for ease of fabrication/ production/ assemble
♣ Minimize assembly paths
♣ Avoid separate fasteners (i.e. monolithic units)
♣ Eliminate adjustments as possible (i.e. movement in parts addressing multiple use – it's a trade-off)
♣ Design for minimum handling
♣ Avoid use of additional tools when possible
♣ Minimize subassemblies (i.e. joining and removing some of the parts)
♣ Use standard parts when possible (refer/ revise to LNM)
♣ Simplify operations
♣ Design for efficient and adequate testing (refer/ revise to LNM)
♣ Use repeatable & understood processes
♣ Analyse failures
♣ Rigorously assess value (i.e. cost of production against minimizing cost of human efforts being done at present – Refer to AEIOU observation framework)

4. Design for Cost, Environment:

- Design for cost means designing for lowest possible life cycle cost. It involves – assumed product design cost (manufacturing), delivery cost (to the end-user) as well as cost of operation and maintenance.
- Design for environment strategy describes best practices of designing a product/process to minimize health and environmental ill-impacts. Four main concepts of Design for Environment includes: (a) Design for Environmental aspects during Processing and Manufacturing; (b) Design for Environmental aspects in Packaging; (c) Design for Disposal or Reuse (i.e. after end of product/ process life-cycle as involved in one's case); (d) Design for Energy Efficiency (i.e. energy consumption during the product/ process usable life)

5. Modelling and Analysis using Software:

- Branch Specific software can be used for simulation/analysis purpose to further refine the design before investing more time, money and resources.

6. **Prototyping and Proofing of Concepts:**

- Prototypes, Models and Proof of concepts
  - Prototypes [1]: Prototypes are the first full scale and usually a functional form of design and in this sense, it is a working model of designed parts/artefacts. They are tested in the same environments in which they are expected to perform as final products.
  - Models [1]: A model is "a miniature representation of something". They may be a paper model or computer model or physical model. Models are usually a smaller and made of different material than are of original products, and they are tested in laboratory or controlled environment to validate their expected behaviour.
  - Proof of Concepts [1]: A proof of concept, in this context, refers to a model of some part of a design that is used specifically to test whether a particular concept will actually work as proposed. Proof of concept test will validate the idea or concept in controlled environment.

- Building series of Prototypes to further refine the project
- How much it will cost?

7. **Engineering Economics of Design:**

- Cost Estimation
- Labour, Material and overhead cost
- The time value of money

8. **Design for Use, Reuse and Sustainability**

- Design for USE – How long this design will work?
  - o Reliability
  - o Maintainability
- Design for Reuse
- Design for Sustainability

9. **Test the prototype**

- Test your design in real operational environment and then iterate if required.

[1] Engineering Design – A project Based Introduction by Clive L. Dym, Patrick Little, Elizabeth J. Orwin – Wiley publications

10. **Ethics in Design**

- Codes of Ethics
- Ethics: Understanding Obligations
- Ethics: on engineering practice and the welfare of the public
- Ethics: Always a part of engineering practice

Optional Areas:

GTU Innovation Council will help in below areas for the students whose projects are innovative & extraordinary and who really want to develop their projects further.

Visit **http://www.gtuinnovationcouncil.ac.in/** or **http://dic.gtu.ac.in/** for more info.

- Design and Product Development Support
- Intellectual Property Right
- Business Model Canvas
- Student Start-up, Funding, Idea to Product
- Incubation and Co-working space

♦ Submissions by the end of 6th semester shall be:

A. Process Report comprising:

a. Introduction (Describe your project in detail including domain – type, place, why and how team selected this domain and why this domain is important in relation to Design Thinking/Human-Centred process etc.)

b. Canvases and framework from 5th semester based on different phase of Design Thinking

c. Feedback analysis with the user and Summary on validation process and refinement in the rough prototype shall be clearly included in the report

d. Detail design calculations/data

e. CAD/Software modelling details

f. Testing of final model if available

g. Any other important aspects you feel should be included

B. Iterative versions of the prototype models with all necessary details

C. Individual Log Book (duly signed by faculty guide)

D. Continuous Assessment Card for Internal Evaluation (Document separately available on GTU website)

Note:

As per the guidelines and evaluation schemes given in this document, students need to prepare report for their projects. Separate report format will not be provided by University, students and faculty members may create their own creative formats. However, in general guidelines document uploaded on GTU website, there are some report format links are given which may help for report format.

Appendix 1: The END SEMESTER Evaluation Scheme for

Design Engineering – II B (3160001) (6th Semester)

BE III year – all branches

To,

The Principals/Directors of Colleges/Institutes, the Heads of Departments and GTU/Design Engineering coordinators:

Students deserve a proper practical/ viva/project examination of the work that they have done over the semester (or over the year for a 2-semester project). It is the responsibility of the University and Colleges that all its examinations are conducted fairly, sincerely and with due diligence. So please look into the following:

1. Please make proper arrangements so that all the examinations start in-time. If due to any reason, the exam should not start at the scheduled time, please inform the examiners that they should take extra time. But in no case the viva/ practical exam be conducted in a hurry without giving sufficient time for evaluation of every student. If an exam is scheduled to be held over two days, please make the necessary arrangements.

2. The University expects the Deans (and or special teams headed by the Dean or his/ her nominee) to visit the Colleges during the practical/ viva examinations. As it came to University's notice that some examiners and colleges are completing viva exam in 1- or 2-hours' time of entire class which is not acceptable in any case and its immoral practice for any education institute. So, all stakeholders need to take extra care of this issue.

3. Please see that all the necessary help and information is provided. Please receive them so that they can do their job properly without wasting their time in searching for the place and in contacting the concerned examiners and students. If they should want to visit the laboratories/ workshops, please make the necessary arrangements.

4. Please inform the external examiner that he/she must note down the best 3 projects of the department and convey the details of such projects by uploading the details of the project or/ and the complete project report on the University's server or send it to design@gtu.edu.in.

5. In case Internet or the server should not work, please provide the technical help to the external examiner for preparing a CD of the reports of the best three projects of every department and please make arrangements to deliver the CD to the examination department of the University.

PROCESS OF EVALUATION: At the ensuing 6th semester examinations, the work of the students in Design Engineering-2B is to be evaluated by **External VIVA** and the evaluation is to be out of 80 marks.

A Viva-Voce examination will be conducted at the end of the semester **by a team of two examiners**, one of whom will be an internal Faculty Member, who may have taught the subject. (Internal examiner must remain the same throughout the entire of examination for batch). The other will be an external examiner to be appointed by the University. Both examiners must be trained in Design Thinking through the FDP conducted by University.

EVALUATION SCHEME

Sr. No.	Particular	Sub-Head Weightage
1.	• Design calculation (it may include size & shape specifications, tolerances, material requirement, standards/safety rules/govt. policies, sketches, detail & assembly drawings, list of components with specifications etc.) These all aspects are case sensitive so one can add/remove some aspects from the list. • For CE, IT, other process related branches, one may also use Flow chart/Block Diagrams/Algorithms/Programming etc. • Measuring Instruments/techniques - knowledge and use • Comparison of existing materials, methods, tools and equipment for your project **Detail Design:** Considerations for **Design for Performance, Safety and Reliability** ➢ Different aspects of design for performance, safety and reliability introduced/ considered for defined problem **Design for Ergonomics and Aesthetics** ➢ Consideration of Ergonomics and Aesthetics aspects to raise the value of product **Design for Manufacturability & Assembly (DFMA)** ➢ Reference, different considerations and guidelines followed for DFMA during the work **Design for Cost, Environment** ➢ Cost and Environment consideration as they play major role in Product **Design for Use, Reuse and Sustainability**	25
2.	Simulation & Analysis (CAD/Software modelling), Mathematical model	15
3.	**Prototyping & Testing:** ➢ Versions of Prototypes with all possible modification and iterations to further refine the solutions (15 marks out of 25 - for	

	students who have made iterative versions for prototype with refinement; if students only present final prototype without any version/s or modification/s then this 15 marks will not be counted for such students) Note: Report should carry all details/modification for the versions of prototype with images, it is not required to have different physical models for the different versions ➢ Testing/user feedback results (10 marks out of 25 - if the details and testing/user feedback results are there) ➢ Video of Prototypes (YouTube link)	25
4.	**Report, Logbook, Continuous Assessment Card:** Compilation of work report (process report), duly signed Logbook and Continuous Assessment Card, Online Certificate generated through DE Portal, Future action plan, Question and Answer, Communication Skill, Attitude	15
		Total: 80

Note:

1. Total Marks for the subject: 100 (Practical viva – 80 (External – 40 & Internal – 40), Internal continuous evaluation – 20)
2. Minimum passing marks: 40/80
3. Ratio of evaluation by internal & external examiner appointed: 50% in each sub-head
4. Examiner essentially needs to evaluate the learning process of the student during the semester, not only the final outcome. As outcome is important for any project but during the student stage, projects are intended for practical learning and "Learning by doing" is the Mantra for Design Engineering subject (One should celebrate the failure also and learn from it to get success). So please evaluate the Design Thinking process and their learning properly with giving sufficient time for each project.
5. Students need to explain all canvases prepared in hard copy to the panel of examiners (internal and external).
6. Power point presentation is not mandatory.

Note:

In final year, students will use their learning of Design Thinking from these four modules of DE-1A, 1B, 2A, 2B to complete their IDP/UDP projects. There would not be separate Design Engineering subject in final year. On successfully completion of these four modules and repeating Design Thinking process again and again, students would be able to use it effectively and can solve any problem with creativity.

For any query & suggestions, kindly contact : design@gtu.edu.in

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160002
Contributor Personality Development Program

SEMESTER VI

Type of course: Work-Personality Development

For Year: Pre-final year for all Diploma, Degree & Masters programmes over 2 semesters. For e.g. for Bachelors of Pharmacy and Engineering, the course will be conducted in Semesters V & VI.

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	0	2	70	30	30	20	150

COURSE CONTENT :

Sr. No.	Content	Total Hrs
1	**Finding Solutions** The market environment in which organizations are operating, is becoming increasingly dynamic and uncertain. So, employers are increasingly seeking out people who can innovate and figure out solutions in the face of any challenge (unlike in the past when it was the	1.5 hrs Classroom engagement (including self-discovery/ solutioning sessions)

	people who were most efficient and productive, who were valued by organizations). At the heart of innovation lies this way of thinking of "finding solutions" rather than "seeing problems or roadblocks". Students learn how to build this way of thinking, in this topic.	
2	**Creating Value** Companies are also looking for employees who do not just work hard, or work efficiently or productively - but those who will make a valuable difference to the fortunes of the company. This difference may come from innovation, but it may also come from focusing on the right things and identifying what really matters – both to the company and to the customers. In this topic, students learn how to build this capability.	Same as above
3	**Engaging deeply** The environment we live in is becoming increasingly complex because more and more things are getting interconnected, new fields are emerging, technologies are rapidly changing, capabilities and knowledge one is trained in will become fast obsolete. In such a scenario, the student's ability to quickly understand and master what is going on, dive deep, get involved in any area, rapidly learn new capabilities that a job demands, is important. Engaging deeply is a core way of thinking that can help them in this. In this topic, students learn how to engage deeply.	Same as above
4	**Enlightened self-interest & collaboration at work** The changing nature of work in organizations and in the global environment is increasingly demanding that people work more collaboratively towards shared goals and more sustainable goals. A key to working successfully when multiple stakeholders are involved is "thinking in enlightened self-interest". In this topic, students learn how to develop this way of thinking (going beyond "narrow self-interest").	Same as above
5	**Human-centered thinking & Empathy** In this topic, students explore a human-centric approach to work – where the ability to recognize and respond to other people (whether they are users or customers or team members) as a human being with human needs and difficulties, is essential. This is at the heart of user-centric design of products and solutions, at the heart of genuine customer-centricity in services, and of any successful interaction with other people.	Same as above
6	**Trust Conduct** The biggest currency in a sustainable career is "trust" i.e. being trusted by team members, bosses, and customers. When we are trusted, people listen to us, they are willing to give us the chance to grow, give us the space to make mistakes, and work seamlessly with each other without always having to "prove ourselves". In this topic, students learn how to demonstrate conduct that builds the trust of people.	Same as above
Showcase Lab Sessions		3 hrs
Project work		Beyond classroom

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160002

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
-	**15**	**15**	**-**	**20**	**20**

Reference resources:

A. Basic reference for both students and teachers

1. Contributor Personality Program textbook cum workbook developed by Illumine
2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

B. Advanced reference for teachers

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan
4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007
9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160002

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
Outcome of theory sessions		
CO-1	Students will be able to recognize & appreciate the thinking required to find solutions in the face of any challenge.	10-12%
CO-2	Students will be able to recognize & appreciate different types of value that can be created and the different ways to create value for others.	10-12%
CO-3	Students will be able to recognize & appreciate how to engage deeply, and its need, value, payoffs and consequences in different contexts.	10-12%
CO-4	Students will be able to differentiate between 'enlightened self-interest' and 'narrow self-interest' & appreciate the payoffs/ consequences of both when working with multiple stakeholders.	10-12%
CO-5	Students will be able to recognize & appreciate the human side of situations or interactions or projects that will help them develop a more human-centric approach/ response to work.	10-12%
CO-6	Students will be able to recognize & appreciate conduct which builds trust of people in contrast to conduct which breaks trust of people - in teams / organization & the value of trust conduct in various situations.	10-12%
Outcome of practical sessions		
CO-7	Students complete their 'Contributor Showcase Profile' on the Showcase Platform. This includes (a) completing Illumine's Contributor Mindset Assessment (b) building evidence to demonstrate their functional orientations as contributors.	15%
CO-8	Students learn to apply contributor thinking to think-through and address real-world challenges.	15%

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160003
IPDC - 2 (Integrated Personality Development Course)

SEMESTER VI

Type of Course –

Value-based holistic personality development course for university students.

Rationale

IPDC aims to prepare students for the modern challenges they face in their daily lives. Promoting fortitude in the face of failures, unity amongst family discord, self-discipline amidst distractions, and many more priceless lessons. The course focuses on morality and character development at the core of student growth, to enable students to become self-aware, sincere, and successful in their many roles - as an ambitious student, reliable employee, caring family member, and considerate citizen.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	0	2	70	30	30	20	150

The assessments should include both continuous evaluation and end-of-semester examinations. The assessment scheme should include student attendance, assignments, mid-term exams, viva, workbook submission, and end-of-semester examinations.

Course-Content :

Each lecture can be taken in a continuous two-hour session, or in two separate one-hour sessions. In addition to the core lectures, an induction and concluding lectures are recommended as shown in the below table.

Lecture No.	Module -Lecture	Lecture Description	Hours
IPDC-2			
1	**Remaking Yourself-** Begin with the End in Mind	Students will learn to visualize their future goals and will structure their lives through smart goals to give themselves direction and ultimately take them to where they want to go.	2
2	**Remaking Yourself-** Being Addiction-Free	Students will explore the detrimental effects of addictions on one's health, personal life, and family life. They will learn how to take control of their life by becoming addiction free.	2
3	**Selfless Service-** Case Study: Disaster Relief	Students will apply previous lessons of seva, to analyse the case study of the Bhuj earthquake relief work.	2
4	**Soft Skills-** Teamwork & Harmony	Students will learn the six steps of teamwork and harmony that are essential for students' professional and daily life.	2
5	**My India My Pride-** Present Scenario	To implement the transformation of India from a developing country into a developed country it is necessary to have a value-based citizen. Students will see how the transformation to a greater India relies on the vision and efforts of themselves as a youth.	2

6	**Learning from Legends-** Leading Without Leading	Students will explore a new approach to leadership, through humility.	2
7	**My India My Pride-** An Ideal Citizen - 1	Students will learn that to become value-based citizens, they must first develop good values in their lives. They start by exploring the values of responsibility and integrity.	2
8	**My India My Pride-** An Ideal Citizen - 2	Students will learn that by developing the values of loyalty, sincerity, and punctuality; they become indispensable and can leave a strong impression. They will start developing these values by trying to keep perfection in every small task and by looking at the bigger picture.	2
9	**Facing Failures** Timeless Wisdom for Daily Life	Students will learn the role wisdom plays in finding long-term stability. They will use ancient wisdom to solve their modern-day challenges.	2
10	**From House to Home-** Forgive & Forget	Students will understand the importance and benefits that forgiveness plays in their personal and professional life. They will learn to apply this knowledge in realistic situations.	2
11	**Remaking Yourself-** Stress Management	Students will learn to cope with current and future causes of stress.	2
12	**Remaking Yourself-** Better Health Better Future	A healthy body prevents disease and stress; increases positivity, productivity, and brainpower. Students will learn to maintain good health through regular exercise, healthy eating habits, and regular and sufficient sleep.	2
13	**Learning from Legends -** Words of Wisdom	A panel of learned and experienced mentors will personally answer practical questions that students face in their daily life.	2
14	**Soft Skills –** Financial Planning	Students will develop a variety of practical financial skills that prepare them to become financially stable throughout their future careers.	2
15	**Remaking Yourself** Impact of Company	Students will understand that the type of company that we keep, has a crucial role in determining who we are and who we will become. They will develop the ability to create a positive environment around them.	2
Concluding	Life After IPDC	This concluding lecture encourages students to keep practising these priceless lessons and prepares them for the next steps in their lives.	2

- **COURSE MATERIAL / MAIN COURSE WORKBOOK -**

1. IPDC Workbook-2 *(presented by B.A.P.S. Swaminarayan Sanstha)*

IPDC REFERENCES –

These are the reference material for the IPDC lectures. This is not compulsory reading for the students as the essential information is contained in the workbooks.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160003

Module No.	Module	References
1	Facing Failures	1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914 2. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 2017 **3. J.K. Rowling Harvard Commencement Speech | Harvard University Commencement, 2008** 4. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 2014 5. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007 6. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015 7. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007
2	Learning from Legends	1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life-Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013
3	My India My Pride	1. Rishis, Mystics, and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpith, 2011 2. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 3. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982 4. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark, University of Chicago Press, reprint, Kessinger Publishing, 2006
4	Remaking Yourself	1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017
5	From House to Home	1. "What Makes a Good Life? Lessons from the Longest Study on Happiness", R. Waldinger, Ted Talks, 2015 **2. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 1995** 3. Outliers, Malcolm Gladwell, Back Bay Books, 2011
6	Soft Skills	1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 2013 2. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 2015 3. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Dan Ariely, Harper Perennial, 2010
7	Selfless Service	1. Open: An Autobiography, Andre Agassi, Vintage, 10 August 2010 2. The Physiological Power of Altruism [online], James Hamblin, The Atlantic, December 30, 2015, https://www.theatlantic.com/health/archive/2015/12/altruism-for-a-better-body/422280/ [last accessed June 10, 2020]

		3. TBI Blogs: From Entrepreneurs to Doorkeepers, Everybody Serves with Love & Warmth at This Ahmedabad Café [online], The People Place Project, The Better India, May 29, 2017, https://www.thebetterindia.com/102551/small-way-serve-ahmedabad-seva-cafe/, [last accessed June 10, 2020]

Course Outcomes

- To provide students with a holistic value-based education that will enable them to be successful in their academic, professional, and social lives.
- To give the students the tools to develop effective habits, promote personal growth, and improve their wellbeing, stability, and productivity.
- To allow students to establish a stronger connection with their family through critical thinking and devolvement of qualities such as unity, forgiveness, empathy, and effective communication.
- To provide students with soft skills that complement their hard skills, making them more marketable when entering the workforce.
- To enhance awareness of India's glory and global values, and to create considerate citizens who strive for the betterment of their family, college, workforce, and nation.
- To inspire students to strive for a higher sense of character by learning from role models who have lived principled, disciplined, and value-based lives.

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: ALL (Except Computer Engineering / IT Engineering and Allied Branches)

Course / Subject Code : 3160004

Subject Name: Fundamental of Semiconductor Package Manufacturing and Test

w. e. f. Academic Year:	2024-25
Semester:	6th Semester
Category of the Course:	Open Elective – II

Prerequisite:	Electrical, Electronics, Materials or Mechanical Engineering Programs; Production Technology, Industrial Engineering, Foundational Statistics, Data Processing and Computer Programming (Unix/Perl/C/Python)
Rationale:	This course aims to empower students with the knowledge essential for semiconductor package manufacturing and testing.

Course Outcome:

After Completion of the Course, Student will able to gain:

No	Course Outcomes	RBT Level
01	Comprehensive knowledge of the various processes involved in semiconductor package assembly and the critical manufacturing aspects.	RM and UN
02	Knowledge on IC package testing as part of ATMP (Assembly, Testing, Marking and Packaging) requirement.	UN and EL
03	Knowledge on Package qualification requirements for semiconductor Industry needs.	UN and AN
04	Knowledge on Electrical and Mechanical Failure analysis for semiconductor packages	UN and EL
05	Knowledge from Semiconductor Industry experts on real time applications.	UN and AP

**Revised Bloom's Taxonomy (RBT)*

**RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	0	3	70	30	0	0	100

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**PACKAGE MANUFACTURING PROCESSES** Packaging Assembly Technology, Wafer Thinning, Dicing, Die Attach, Wire bonding, Flip Chip process, Flux Cleaning, Underfill, Encapsulation, Laser Marking, Solder Ball Attach, Reflow, Singulation, IC Packaging Toolsets & equipment operation, clean room operations	9	20%
2.	**SEMICONDUCTOR COMPONENT AND PACKAGE TEST** Overview of Testing methodologies, components tested & their characteristics, Challenges in testing, Types of Testers (Automated test equipment & Benchtop Testers), Components & Subsystems of Testers, Principles of Functional Testing, Parametric/ Boundary Scan /In-Circuit Test/ Flying Probe Test, Test Data Analysis, Design for Testability & Tester Calibration & Maintenance, Future Trends	9	20%
3.	**SEMICONDUCTOR PACKAGE MATERIALS AND QUALIFICATION** Reliability testing & qualification- MST/MSL, TC/TS, HAST & uHAST, Mold Compounds (Moldability), Underfill Materials, Die Attach Adhesives & Films, Substrate Technology, Bonding Wire, Solder & Dielectric materials	7	20%
4.	**ELECTRICAL AND PHYSICAL FAILURE ANALYSIS** Package failure modes, Failure detection mechanisms, Failure analysis tools, Test programs debugging, Data Analytics, ESD & EMI Management	8	20%
5.	**INDUSTRIAL QUALITY AND STATISTICAL PROCESS CONTROL** Quality Control Plan (QCP) & Quality Management System (QMS), Incoming Material Inspection, In-Line Quality, Measurement System Analysis, Statistical analysis methods, Statistical Process Control (SPC), Fault Detection Control (FDC), Run-to-Run Control (R2R), Auto Defect Classification (ADC), Data Analytics, Machine Communication Protocol and System Integration	7	20%
	Total	**40**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**50**	**10**	**10**	**10**	**0**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Lau, J. H. (2021). Semiconductor Advanced packaging. Springer Nature
2. Bar-Cohen et al. (2019). Encyclopedia of Packaging Materials, Processes, and Mechanics. In WORLD SCIENTIFIC, https://doi.org/10.1142/11303
3. Moyne, J., Del Castillo, E., & Hurwitz, A. M. (2000). Run-to-Run control in semiconductor manufacturing. CRC Pres
4. Emiliano R. Martins (2022). Essentials of Semiconductor Device Physics. Wiley.
5. C++ textbook
6. Python textbook
7. Harman, G. (2010). Wire Bonding in Microelectronics, 3/E. McGraw-Hill Education.
8. Ardebili, H., Zhang, J., & Pecht, M. G. (2018). Encapsulation technologies for electronic applications. William Andrew.
9. Chen, A., & Lo, R. H. (2016). Semiconductor packaging: Materials Interaction and Reliability. CRC Press
10. Gan, C. L., & Chen-Yu, H. (2023). Interconnect reliability in advanced memory device packaging. Springer.
11. Roffel, B., & Betlem, B. H. (2004). Advanced practical process control. In Springer eBooks

(b) Open source software and website:

1. C++
2. Python

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161707
CONTROL SYSTEM DESIGN
6th SEMESTER

Type of course: Professional Elective Course

Prerequisite: Knowledge of engineering mathematics, basics of control theory, simulation know-howon Matlab/ Scilab or other equivalent software

Rationale: The course is useful for the students to get idea of ideal practices in the field of control systemsdesign. This makes students capable for further studies and/ or conducting research work in the field. Students get in touch with recent trends in the field of modern control engineering. Importance of designing the control systems is emphasized.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Design of Feedback Control Systems :** Introduction; Approaches to System Design; Cascade Compensation Networks; Phase-Lead Design Using the Bode Diagram; Phase-Lead Design Using the Root Locus; Phase-Lag Design Using the Root Locus; Phase-Lag Design Using the Bode Diagram; lead-lag Design using root locus and bode diagram Design Examples.	**12**	33
2	**Design of State Variable Feedback Systems** Introduction, State space representation of physical systems, State space models of some common systems like R-L-C networks, DC motor, inverted pendulum etc., Controllable Canonical Form, Observable Canonical Form, Diagonal Canonical Form, State transition matrix, Solution of state equations, Controllability and Observability, Full-State Feedback Control Design; Observer Design; Integrated Full-State Feedback and Observer.	**12**	33
3	**Introduction to Optimal Control** introduction to optimal control, Riccatti Equation, Linear Quadratic Regulator, Design Examples.	**6**	16

4	**Introduction to Robust Control** Robust control system and system sensitivities to parameter perturbations, analysis of robustness, systems with uncertain parameters, considerations in design of robust PID controller.	**6**	18

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**14**	**14**	**14**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Modern Control Engineering by K. Ogata, PHI.
2. Discrete Time Control Systems by K. Ogata, PHI.
3. Automatic Control Systems by B C Kuo, PHI.
4. Control Systems, Principles and Design by M. Gopal, MC Graw Hill, 2012.
5. Modern control systems / Richard C. **Dorf**, Robert H. **Bishop, Pearson.**

Course Outcome:

After learning the course the students should be able to:

CO1 Apply time domain techniques to analyses and design closed-loop control system.
CO2 Apply frequency domain techniques to analyses and design closed-loop control system.
CO3 Apply state variable approach to design control systems
CO4 Understand optimal control and design closed loop optimal control system
CO5 Understand robustness of control system and design robust controller for a system with parameter uncertainties

List of Experiments:

*(Followingpracticals are recommended but they are not limited for modifications and or alterations by the faculty member/s teaching the particular subject. The use of MATLAB or SCILAB or equivalent software is suggested.***)**

1 Analysis of root locus using MATLAB.
2 Design lead compensator using time response analysis using MATLAB and design lead network.
3 Design lag compensator using time response analysis using Matlab and design lag network.

4 Find stability of any state space model using eigen value analysis and plot it state response.
5 Check controllability and observability of the given state space models.
6 Design state feedback controller using pole placement method based on MATLAB.
7 Analysis of bode plot using MATLAB.
8 Analysis and design of frequency response of lead compensating network.
9 Analysis and design frequency response of lag compensating network.
10 Design optimal controller using Riccatti equation
11 Design robust PID control system and check its response using Matlab.
12 Studying any prototype closed loop system.

All practical can be designed in MATLAB or SCILAB ,/Proteus /Keil.

Major Equipment:

Educational prototype models, Computers, simulation software, microcontrollers etc.

List of Open Source Software/learning website:

http://nptel.ac.in/courses/108103007/16

https://en.wikipedia.org/wiki/State-space_representation

http://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=ControlStateSpace

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161708
SUBJECT NAME: Motion Control

Type of course: Core Engineering

Prerequisite: DC machine and AC machine, Power Electronics, Control Theory and Motion Sensors Basics.

Rationale: Industrial Applications involves Motion Control as the major field to operate various drives involved. These Drives are selected based on power, torque, speed, size, load, control strategies, cost and many other factors. It is necessary for an engineer to select proper Machine for drive application based on these aspects. This Course deals with various machines, their models to understand its operation and finally its closed loop drive operation, to enable student to identify proper drive for motion control application.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Sr. No.	Course Content	Hrs	Weightage %
1	**Introduction** Components of a Motion Control System, Human–Machine Interface, Motion Controller ,Drives, Actuators, Transmission Mechanisms, Feedback	4	10
2	**DC Machines – Modeling & Motor Parameters** Induced Emf-equivalent circuit & Electromagnetic Torque-Electro-mechanical Modeling- State-Space Modeling- Block Diagram & Transfer Function-Field Excitation- Measurement of Motor Constants.	4	10
3	**Control of DC Drives:** Controlled rectifier based drives, Phase-Controlled Converters, Design of Controllers, Four-Quadrant DC Motor Drive, Closed Loop speed control of Drives. Chopper Control of DC Drives: Principle of operation of the Chopper-Four-Quadrant Chopper Circuit-Chopper for Inversion-Model of Chopper-Input to the Chopper-Other Chopper Circuits-Closed Loop Operation.	10	24
4	**AC Machines – Modeling & Motor Parameters** Construction and Principle of Operation, Induction Motor Equivalent Circuit, Measurement of Motor Parameters, Modeling of Induction Machines, Control Principle of Induction Motor.	4	10
5	**Control of AC Drives:** Control of Induction Motor by AC Voltage Controllers, AC Voltage Controller Circuits, Frequency Controlled Induction Motor Drives, Voltage Source Inverters based control, Constant Volts/Hz Control, Current Source Inverter based control, Current Controlled PWM Inverters, Induction motor Speed control by the use of adjustable frequency PWM inverters—properties of PWM waveforms, single pulse modulation, Multi-pulse modulation, sinusoidal modulation.	10	24
6	**Permanent Magnet Synchronous and Brushless DC Motor Drives:** Synchronous Motors with PM, Control Strategies, Speed Controller Design, PM Brushless DC Motor, Sensorless Control of PMBDCM.	4	10
7	**Stepper Motor Drive:** Stepper motors - Variable reluctance, Permanent	6	12

	Magnet, Torque versus stepping rate characteristic, Drive circuit for stepper motors.		

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Construct Model of AC/DC Machine with all electrical and mechanical parameters consideration.	
CO-2	Design AC and DC Drive with Control parameters.	
CO-3	Design Special Motor Drives using BLDC and Stepper Motor	

Reference Books:

1. Electric Motor Drives–Modeling, Analysis and Control, -R. Krishnan, Pearson Education, 2003
2. Fundamentals of Electrical Drives- Gobal K.Dubey, Alpha Science Int. Ltd., Pangbourne
3. Power Electronics & Motor Control - Shepherd Hullay & Liag, Cambridge Univ. Press
4. Power Semiconductor controlled Drives, -Gopal K Dubey Prentice Hall pub.
5. Industrial Motion Control, Motor Selection, Drives, Controller Tuning, Applications– Hakan Gürocak, Washington State University Vancouver, USA, Wiley Publications.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161709

SUB NAME : **Safety Instrumented System**

Semester – VI

Type of course:

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Sr No.	Course Content	Hrs	Weightage %
1	Introduction of safety instrumented system Safety Instrumented system, Confusion in the industry, industry guidelines-standards and regulations, standards are changing their direction, things are not as obvious as they may seem	3	10
2	Design Lifecycle Hindsight/Foresights, Findings of the HSE, Design life cycle, SIS design & Engineering ,Installation, commissioning and validation, operation and maintenance, decommissioning	2	7
3	Process control vs. safety control : Control and safety defined, process control-active/dynamic, safety control-passive/dormant, separation of control and safety systems, Common cause and systematic/functional fallers	2	10
4	Protection layers: Prevention layers, mitigation layers, Diversifications	3	10
5	Developing the Safety requirement specifications Introduction, why are 44%n of accidents caused by incorrect specifications?, ANSI/ISA-84.00.01.2004,part 1-3 requirements, documenting the specifications requirements.	3	10
6	Determining SIL Introduction, common issues, evaluating risk, Safety integrity level,SIL determination methods(ALARP and Risk matrix, risk graph, LOPA)	3	10
7	Choosing a technology Phumatic systems, relay systems, solid state systems, microprocessor/PLC(software based)systems, issues related to system size, issue related to system complexity, communication with other systems,certified vs prior use	2	8
8	Initial system evolution Things are not as obvious as they may seem, why systems should be analyzed before they are built, need to get failere rate information, failure	4	15

	modes, metrics, degree of modeling accuracy, modeling methods, the real impact of redundancy, analysis of a relay system, non redundant PLC system, TMR systems, Field devices, fault tolerance requirements, Sample SIS design cookbook, Engineering tools available for analyzing system performance		
9	Issue relating to field devices Introduction, importance of field devices, Sensors, Final elements, Redundancy, Design requirements of field devices, Installation concerns, Wiring of field devices	2	10
10	Engineering a system General management considerations, General hardware consideration, General software consideration	2	10

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Able to explain Safety instrumented system and SIL, choosing technlology	
CO-2	Able to analyze the safety specification for process control and safety control of various processes	
CO-3	Will be able to analyze failure of field devices and apply modifications	

Text Books

1. Safety Instrumented Systems:Design,Analysis and Justification 2nd edition by Paul Gruhn,P.E. and Harry L. Cheddie,P.E. Published by ISA.(ISBN -13 978-1-55617-956-3)
2. Safety Instrumented Systems: A Life Cycle Approach by Paul Gruhn and Simon Lucchini
3. Safety Instrumented System Design: Techniques and Design Verification by William M. Goble

Reference Book

1. Safety Instrumented Systems Verification: Practical Probabilistic Calculations by William M. Goble
2. Safety Integrity Level Selection: Systematic Methods Including Layer of Protection analysis by Eric William Scharpf

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161710
Semester – VI
Subject Name: Artificial Intelligence and Machine Learning

Type of course: Core Engineering

Prerequisite: Knowledge of engineering mathematics, basics of algorithms, simulation know- howon Matlab/ Scilab or other equivalent software

Rationale: AI ML is very useful in Industry 4.0. Machine Learning enables IT systems to recognize patterns on the basis of existing algorithms and data sets and to develop adequate solution concepts. Therefore, in Machine Learning, artificial knowledge is generated on the basis of experience.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

S. N.	Content	Total Hrs	% Weigh tage
1	**Artificial Intelligence** - Overview, Supervised and unsupervised learning, Learning task, instances, features, labels, reward/loss, training, testing	02	5
2	**Gradient Descent and Linear Algebra** Model representation, cost function, mathematics of gradient descent, gradient descent intuition, gradient descent for linear regression, matrix, vector, transpose matrix, matrix multiplication, and matrix multiplication properties, inverse of matrix.	04	15
3	**Multiple features gradient descent** Multiple features, gradient descent calculations for multiple features, features and polynomial regression, normal equations, linear regression with multiple variables.	04	15
4	**Classification** Overview of classification: setup, training, test, validation dataset, over fitting. Classification families: linear discriminative, non-linear discriminative, decision trees, probabilistic (conditional and generative), nearest neighbor and Logistic regression.	04	10
5	**Support Vector Machine** Max margin motivation: low density, high stability, Margin geometry to primal SVM formulation for separable training data, Dual formulation and role of alpha in a form of sparse local regression, Inseparable data, slack variables, hinge loss, upper bound on 0/1 training loss Handling non-linear regression by lifting data points to higher dimension	06	20

6	**Dimensionality reduction** Curse of dimensionality, Principal Component Analysis, Latent Semantic Analysis	04	10
7	**Artificial Neural Network** Model representation, working of neurons, back propagation algorithm, adjusting parameters, multiclass classification, bias value, random and Gaussian initialization of parameters, final implementation of ANN	04	10
8	**Unsupervised learning** Mixture model and Expectation maximization, K-Means Clustering, Distance based clustering, Density based clustering techniques	02	5
9	**Ensemble learning** Random forest, Adaboost	02	5
10	**Gradient Descent with large data set** Stochastic gradient descent, mini batch gradient descent, stochastic gradient descent convergence	02	5

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**14**	**14**	**07**	**07**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Text Books

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach," *3rd edition, Prentice Hall*

2. Tom Mitchell, "Machine Learning", *McGraw-Hill,1997*

3. EthemAlpaydin, "Introduction to Machine Learning", *PHI,2005*

4. Bishop, C., "Pattern Recognition and Machine Learning:," *Berlin: Springer-Verlag, 2006*

Reference Books/Courses

1. K.P. Soman, R. Longonathan and V. Vijay, "Machine Learning with SVM andOther Kernel Methods", *PHI-2009*
2.. T. Hastie, R. Tibshirani, and J. Friedman, "The Elements of Statistical Learning" *2009*
3.Pattern recognition and machine learning by Christopher Bishop, Springer Verlag,2006.
4.Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben David. Cambridge University Press. 2017

Andrew Ng course on Machine Learning, Coursera.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161710

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand Artificial Intelligence and its approaches	
CO-2	Solving problems using Artificial Intelligence	
CO-3	Understand Supervised, unsupervised and semi supervised machine learning algorithm	
CO-4	Apply Gradient descent and linear algebra for problem solving	
CO-5	Apply support vector machine in development of algorithm	

List of Practical:

*(Followingpracticals are recommended but they are not limited for modifications and or alterations by the faculty member/s teaching the particular subject. The use of MATLAB or SCILAB or equivalent software is suggested.***)**

1. Implementation of gradient descent with single variable
2. Implementation of gradient descent with multiple variables.
3. Implementation of linear and polynomial regression.
4. Implementation of logistic regression or binary classification.
5. Implementation of SVM with simple features.
6. Implementation of ANN using back propagation.
7. Learning basic library of python for machine learning to be used in Raspberry PI
8. Loading of SVM in raspberry PI
9. Decision making on the basis of input data on raspberry PI.
10. Implementing K-Means clustering algorithm.
11. Implementation of Principal component analysis.

Design based Problems (DP)/Open Ended Problem:

Major Equipment/Software: Raspberry pie, Python, MATLAB **,** LabVIEW

List of Open Source Software/learning website:

http://vlab.co.in/
www.isa.org
http://nptel.ac.in/video.php
http://www.idc-online.com/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161713
INSTRUMENTATION PROJECT MANAGEMENT
6th SEMESTER

Type of course: Core Engineering

Prerequisite: Sensor/ transducer, field transmitters, converters, final control element, basic instrumentation symbols, process control modes and techniques, Computer based control system architecture

Rationale: For Instrumentation and Control engineer it is very important to know the kind of standard documents available in manufacturing processes along with necessary design, test and calibration procedure. This subject will help student to understand the project procedures and various stages of project like planning, estimation, designing, installation, testing, calibration and commissioning of instruments and systems. Last topic of the syllabus will introduce student with quality manufacturing process.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
2	2	0	4	70	30	0	0	100

Content:

S. N.	Content	Total Hrs	% Weigh tage
1	**Introduction to project management** Definition of project purpose - Scope, time, quality and organization structure. Basic and detailed engineering: Degree of automation, Project S curves, manpower considerations, inter-department and inter-organization interactions, Multi agency interaction. Types of projects and types of contracts e.g. EPC, BOOT etc.	03	11
2	**Project management functions** Controlling, directing, project authority, responsibility, accountability, interpersonal influences and standard communication formats, project reviews. project planning and scheduling, life project engineering and management cycle phases, the statement of work (SOW), projects specifications, bar charts, milestones, schedules, work breakdown structures, cost breakdown structures and planning cycle.	03	11
3	**Project cost and estimation** Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software‘s used in project management.	03	11
4	**Instrument Project Control**	04	14

	Project engineering documents and drawing: Process flow sheets, Mechanical flow sheets, Instrument index sheets, loop wiring diagram, panel drawings and specifications, plot plans, installation details, special drawings, purchase requisition, other documents. **Information required:** Process information, Instrument specifications and standards, piping specifications, Electrical specifications, bid documents, Project procedure, project schedule, Equipment Information, Vendor drawing **Work coordination**: Project manager, process engineer, equipment engineer, Piping design supervisor, Structural, architectural and civil, Electrical, purchasing and expediting and others **Planning hints and Project check list**		
5	**Engineering Design criteria** **Pneumatic versus electronics system, Control centers, Future and spare capacity** **Specifications for various measurement and control groups:** Flow, Pressure, Level, Temperature, Control valves, Control panels, Analytical instruments **Transmission systems:** Pneumatic & Electronic – Materials, Distribution, Terminations and Identification **Process connections –** Take-offs and Piping, Location of taps, Sealing instruments from process, Manifolds and gage valves **Miscellaneous Design Criteria:** Mounting instruments, Selections of units, charts, ranges; Instrument identification, Winterizing, Material of construction, Package equipment systems **Electrical safety:** NEC code, Purging and pressurization, Enclosures, Intrinsic safety	08	28
6	**Construction and Start up** **Organizing:** Documents, schedule, cost control **Ordering and Receiving equipment and Material:** Purchase orders, Material status, storage **Installing instrument systems:** Procedures, Coordination, Good installation practices Calibration **Testing:** Process connections, Pneumatic lines, Electrical **Loop checking:** Flow transmitter , Temperature transmitter, Control valve, Miscellaneous checks **Startup:** Placing instruments in service, Tuning loop controls, evaluating process upsets and disturbances, Repairing or replacing defective equipment, special equipment, Additional control	04	14
7	**Introduction to International quality systems - ISO 9000** Quality management practices worldwide, certifying agencies. Quality, customers and ISO 9000 ISO 9000- A management overview ISO 9000- Quality system Inspection, Test standards and Calibration	03	11

Suggested Specification table with Marks (Theory):

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161713

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**14**	**14**	**14**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Text Books

1. Applied Instrumentation in Process Industries by W.G. Andrew and H.B. Williams, *Gulf Professional Publishing, 3rd ed. 2008*, ISBN-13: 978-0872010475.

2. Project management: A systems approach to planning scheduling and controlling by Harlod Kerzner and Van Nostrand, *John Wiley & Sons, 11th ed., 2013*, ISBN: 978-1-118-02227-6.

3. Successful Instrumentation & Control Systems Design, by Michael D. Whitt, 2nd Edition, 2012, *ISA*, ISBN: 978-1-93600-745-5.

4. ISO- 9000 Concepts, Methods & Implementation by Tapan B. Bagchi, *Wheeler pub., 1995.* ISBN-81-85814-24-4

5. ISO- 9000 Guidelines for the chemical & process industries : By ASQC (American Society of Quality Control) , ISBN-13: 978-0873893527, www.asq.org

Reference Books:

Instrument Engineers Handbook: Process Control by Bela G Liptak, CRC Press, 3rd ed., 1995, ISBN-13: 978-0801982422.

Course Outcome: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the importance of project management from industrial perspective	
CO-2	Estimate cost for implementing various industrial projects	
CO-3	Apply various engineering design criteria for optimized project management	
CO-4	Evaluate and select various sensors and control valve for successful realization of specific project	
CO-5	Follow standard practices as well as procedures for construction and startup of project	

List of Tutorial activties:

1) Study of standards and symbols (ANSI / ISA Std.)
2) Study of specification sheets.
3) Development of Process & Instrument diagram of typical process.

4) Development of Loop Wiring diagram.
5) Cable scheduling.
6) GA and mimic diagram of a control panel.
7) Development of Bar charts for certain project.
8) Prepare the cost estimation sheet for the project under consideration
9) Hands on experience for engineering management software such as MS Project, Primavera, etc.
10) Designing of control valve for liquid/gas/vapor applications as per standard
11) Design of orifice plates for liquid/gas/vapor as per ISO 5167
12) Operating range calculation for transmitters considering different applications.

Major Equipment:

Field instruments (includes sensor/ transducers, transmitters, single loop controllers, Converters, control valve, etc.) for flow, level, pressure, temperature parameters.

Test and calibration instruments at least for temperature and pressure parameters.

List of Open Source Software/learning website:

http://vlab.co.in/
www.isa.org
http://nptel.ac.in/video.php
http://www.idc-online.com/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161714

Programmable Logic Controller and Supervisory Control and Data Acquisition System

6th SEMESTER

Type of course: Professional Core Course

Prerequisite: Digital Logic Design, Concept of Micro Processor and Micro Controller, Relay Logic, Control System, Knowledge of programming and flow charts

Rationale: Students of Instrumentation & Control engineering should have detailed skill of controlling any system. Programmable Logic Controller (PLC) is a very important device to control any system and is widely used in industries now a day. Therefore the person who wants to work in control and automation industries must have enhance knowledge of PLC. This course gives a detailed knowledge and practice of PLC programming

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

S. N.	Content	Total Hrs	% Weightage
1	PLC BASICS Programmable Logic Controllers (PLCs): Introduction; definition & history of the PLC; Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; Solid state memory; the processor; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers, PLC Application. Programming equipment; proper construction of PLC ladder diagrams; process scanning consideration; PLC operational faults.	2	4
2	PLC Hardware Components The I/O section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O specifications, The CPU, Memory design, Memory Types, Programming Devices, Selection of wire types and size.	2	4
3	Fundamentals of Logic The Binary Concept, AND, OR and NOT functions, Boolean Algebra, Developing circuits from Boolean Expression expressions, Producing the Boolean equation from given circuit, Hardwired logic versus programmed logic, Programming word level logic instructions. Converting Relay schematics and Boolean equation into PLC Ladder Programs, Writing a ladder logic program directly from a narrative description.	2	4
4	Various INPUT /OUTPUT Devices and its interfacing with PLC. Different types of Input devices : Switches: Pushbutton Switches, Toggle Switches, Proximity switches, Photo	4	8

	switches, Temperature Switch, Pressure Switch, and Level Switch,Flow Switches, manually operated switches,Motor starters, Transducers and sensors, Transmitters etc. Their working, specification and interfacing with PLC. Different types of Output devices : Electromagnetic Control Relays, Latching relays, Contactors, Motors, Pumps, Solenoid Valves etc. Their working, specification and interfacing with PLC.		
5	Basics of PLC Programming Processor Memory Organization, Program Scan, PLC Programming languages, Relay type instructions, Instruction addressing, Branch Instructions, Internal Relay Instructions, Programming Examine if Closed and examine If Open instructions, Entering the ladder diagram, Modes of operation. Creating Ladder Diagrams from Process Control Descriptions. Ladder diagram & sequence listing; large process ladder diagram construction, flow charting as programming method, Industrial Examples	6	12
6	PLC INSTRUCTIONS Bit Logic Instructions: NO, NC, Set, Reset, rising edge Pulse, Falling Edge Pulse, RS, SR, NOP, OUTPUT etc. Clock: READ RTC, SET_RTC. Different Logical operation Instructions: INVERT BIT, BYTE, WORD DOUBLE WORD. OR: BIT, BYTE, WORD DOUBLE WORD. AND: BIT, BYTE, WORD DOUBLE WORD. X-OR: BIT, BYTE, WORD DOUBLE WORD.	3	6
7	Different Integer Math Instructions: Addition, Subtraction, Multiplication, Division, Increment, Decrement- Integer, Byte, Double Word. Different Floating-Point Math Instructions: Addition, Subtraction, Multiplication, Division, Square Root, Sin, Cosine, Tan, LN, Exponential, PID.	4	8
8	Programming Timers Mechanical Timing relay, Timer instructions, ON delay timer instruction, Off-Delay timer instruction, Retentive Timer, Cascading Timers, examples of timer function industrial application; industrial process timing application.	2	4
9	Programming Counters Counter Instructions, Up-counter, down counter, Up- Down counter, Cascading counters, Incremental encoder counter applications, Combining counter and timer functions, High Speed counter instruction, HSC, PLS, examples of counter function industrial application.	2	4
10	Different Conversion Instructions : Byte – Integer, Integer To Byte, Integer To Double Integer, Double Integer To Integer, Real To Integer, Real To Integer, Integer To String, String To Integer, Integer To ASCII , ASCII To Integer, Real To ASCII , ASCII To Real, ASCII To Hexadecimal, Hexa- Decimal To ASCII , Decode,, encode, segment. Truncate.	2	4
11	Different Comparison Instructions Data manipulation, data transfer operations, Data compare instructions, Data manipulation Programs, Numerical Data I/O interfaces, Set-point control.	2	4
12	Program Control Instructions The PLC SKIP and MASTER CONTROL RELAY Functions. Introduction; the SKIP function & application; the MASTER CNTROL RELAY function & application. Introduction: Jump with non-return; jump with return.	3	6
13	DATA HANDLING FUNCTIONS PLC Data Move Systems. Introduction; PLC MOVE function & application; moving large blocks of PLC data; PLC table & registers moves; other PLC MOVE functions. Other PLC Data Handling Functions.	2	4

	Different Move Instructions: BIT, BYTE, WORD DOUBLE WORD, REAL, SWAP Byte, Move Byte Immediate Read, Move Byte Immediate Write. Different Shift/Rotate Instructions		
14	Sequencer and shift register instructions PLC Sequencer Functions. Introduction; electromechanical sequencing; the basic PLC sequencerfunction; a basic PLC sequencer application with timing; other PLCsequencer function; cascading sequencer. Controlling a Robot with a PLC. Introduction; basic two axis ROBOT with PLC sequencer control; industrial three axis ROBOT with PLC control.	3	6
15	Different Interrupt Instructions- ENI, DSI, RETI, ATCH, DTCH, CLR_EVNT.	1	2
16	PLC Networking Introduction, Levels of Industrial Control, Types of Networking, Network Communications.	2	4
17	Analog PLC Operation Introduction, Types of PLC Analog Modules and Systems, PLC Analog Signal Processing, PLC Analog Application Examples, PID Modules, PID Tuning, Typical PID Functions.	2	4
18	Basics of SCADA: SCADA key features, remote Terminal Units (RTU), PLC used as RTU, DCS versus SCADA terminology, SCADA software packages, Application example of SCADA Maintenance, Troubleshooting, Connecting PC with PLC.	2	4
19	Alternative Programming Languages Structured Text, Function block diagram, Instruction list, sequential function chart – Introduction and of few instructions with LD.	3	6
20	Various Brands of PLCs and their revolution. Overview, Siemens PLC, Allen Bradley PLC, Schneider electric PLC, Omron PLC, Mitsubishi PLC. Their comparison of various instructions.	1	2

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**14**	**21**	**14**	**14**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Programmable logic controller by Frank D. Petrusella, Tata McGraw-Hill publication
2. Introduction to programmable logic controller by Gary dunning, Thomson Asia Pte Ltd. Publication, Singapore
3. Programmable Logic Controllers: Principles and Applications by John W. Webb and Ronald A. Reis, Prentice – Hall India publication, 5th edition
4. Programmable Logic Controllers by W. Bolton, Elsevier Newnes publication, 4th edition
5. Programmable Controllers An engineer's guide by E.A.Parr, Elsevier Newnes publication 3rd edition

6. S7-200, PLC Manual of Siemens for Instructions
7. S7-300, PLC Manual of Siemens for Instructions
8. Programmable Controller by T. A. Huges, ISA publication, 2nd edition
9. Programmable Logic Controllers: Programming methods and applications by
10. John R. Hackworth and Frederick D. Hackworth Jr., Pearson publication

Course Outcome:

Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Describe and understand the hardware structure of PLC and interfacing of input-output modules, power supply and computer with PLC	
CO-2	Apply knowledge of digital logic and microcontroller concepts for understanding and use of functional blocks in ladder programming, process scanning and status table updation	
CO-3	Interface different on-off switches, push buttons, keypad, analog sensors etc. with input modules and relay, solenoid valve, LED, servo valve, solid state devices etc. to output modules of PLC	
CO-4	Write, simulate, debug and analyze the ladder programs and SCADA tagging to develop program related to control, arithmetic, relay, data handling, sequencer, timer, counter, interrupt and PID blocks.	
CO-5	Work as an individual and as a team member to design, formulate, implement and troubleshoot industrial automation application using PLC	

List of Experiments:

1. Introduction to ladder programming& to implement basic logic gates.
2. Develop, Simulate and Test Ladder diagram for
   a.a. A Door Bell Operationb. A Combination Lock.
3. Develop, Simulate and Test Ladder diagram for Bottle Filling system.
4. Develop, Simulate and Test Ladder diagram for Traffic Light Control System.
5. Develop, Simulate and Test Ladder diagram for Car Parking system.
6. Develop Simulate and Test Ladder diagram for an alarm annunciator system.
7. Develop Simulate and Test Ladder diagram for Batch Mixer and Drink Dispenser system.
8. Develop, Simulate andTest Ladder diagram for three phase motor and stepper motor control in forward and reverse direction.
9. Develop and test PLC program for two axis Robotic arm for pick and place application
10. Develop, Simulate and Test Ladder diagram for Packing line system and Elevator system
11. Develop and test PLC program for PID Controller for Temperature control Application.
12. Develop and test PLC program in FBD, SFC, IL, ST, and Ladder Logic Language for Motor starter application.
13. Detail study of PLC Hardware and its interfacing.
14. 17. Study of important features of SCADA software package
15. 18.. Study of different type of animations used in SCADA software

16. 19. Development of GUI using different type of scripting on SCADA software
17. . Interfacing of PLC with SCADA software package
18. Interfacing of I/O modules with SCADA/ DCS package

Major Equipment:

Computers, simulation software, PLCs, Input/ Output devices.

List of Open Source Software/learning website:

https://plc-coep.vlabs.ac.in/

http://www.plcdev.com/book/export/html/9

http://www.plcmanual.com/

http://literature.rockwellautomation.com/

http://www.automation.siemens.com/

http://nptel.ac.in/video.php

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161715

INDUSTRIAL DATA COMMUNICATION AND DISTRIBUTED CONTROL SYSTEM

6th Semester

Type of course: Professional Elective Course

Prerequisite: Sensor/ transducer, field transmitters, converters, final control element, basic instrumentation symbols, process control modes and techniques, PLC architecture

Rationale: DCS systems are used extensively in industries. In such computer based automation system; information, communication, and networking technologies have become integral part. So, it is necessary to know hardware interfacing with software driven automation system. This course gives an idea of general structure of DCS and communication protocol system, functional elements, data links, software and algorithms, communication and control aspects of modern plant automation system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

S. N.	Content	Total Hrs	% Weightage
1	**DCS – Introduction & Development History** Early Computer systems: Direct digital control, Centralized computer system, Distributed control Hierarchical Control: Hierarchical computer system for a large manufacturing process, overall task, detail task listing, lower level computer task, higher level computer task	04	10
2	**DCS-Basic packages** Analog control, direct Digital control, Distributed process control, DCS configurations Local Control Units (Relay rack mounted equipment) :Dedicated card controllers, Unit operations controllers, Multiplexers- Design, system configuration, Remote stations, Super-commutation and sub-commutation - Power supplies, - Input/ Output, - Controller file The control console equipment: - Video display, - key board, - peripheral	10	24

	devices, - Displays: Group displays, Overview displays, Detail displays, Graphic displays, Trend displays, Alarm reporting, generation and acceptance Communication between components: Data highway designs, highway compatibility, Network access protocols, Network topologies, Maintenance considerations- Reliability, availability, Single loop integrity, backup systems, Redundant and Fault tolerant systems		
3	**Software configuration** Operating system configuration, - Controller function configuration, - Algorithm libraries, Process control programming: - Types of program, Features of process control programs, The executive program, Programming language for process control Algorithms- The position algorithm, Velocity algorithm, cascade and ratio control, Feed-forward, Other algorithm like Dead band control, emergency response, error squared	06	16
4	**System Integration with PLC and computers** Supervisory computer functions: Supervisory control and optimization, production monitoring and control, on-line information system DCS and supervisory computer displays- Display access method, display features, alarm access architecture, voice input machine interface Man Machine Interface – Sequencing, Supervisory control Computer interface with DCS- Hardware: Gateway, Interface with PLC, Interface with Direct I/O, Network linkages, Links between networks	04	12
5	**Field buses, MAP/TOP, Network protocol** Computer integrated processing, communication hierarchy Industrial communication systems:Management system – MAP/TOP protocol Field buses- fieldbus standardization, Smart transmitters- Rackbus: Bus access method, transmitter, gateways, availability MODBUS - bus access method, application services, transmission modes, function, acceptance PROFIBUS- bus access method, data link services, application services, acceptance FIPBUS - bus access method, other features, acceptance International FIELDBUS standard	10	24
6	**Typical DCS used in Industry.** Honeywell PlantScape system, Foxboro I/A series DCS, Delta system, Citect, Wonderware	04	14

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161715

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**14**	**21**	**14**	**14**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Process Control- Instrument Engineers Handbook by Bela G. Liptak, Chilton book co.
2. Overview of Industrial Process Automation by KLS Sharma, Elsevier pub.
3. Practical Distributed Control Systems (DCS) for engineers and technicians by IDC Technologies
4. Distributed Computer Control Systems in Industrial Autoation by D. Popovic and V. Bhatkar, Marcel Dekker

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Analyze current philosophy, technology, terminology, and practices used in automation industries..	
CO-2	Evaluate computer based automation system used in industries ranging from discrete, continuous process to hybrid processes.	
CO-3	Identify hardware and software for modern automation system required for industrial application.	
CO-4	Apply relevant concept to configure hardware with software for automation application	
CO-5	Understand various communication protocols	

List of Experiments:

1. DCS-Flow-sheet symbol (ch. 7.11- B.G. Liptak –II – Process control)
2. Study of various DCS display options
3. DCS cost estimation procedure (ch. 7.8- B.G. Liptak –II – Process control)
4. Study of stand-alone single loop PID controller
5. Interfacing of different devices using RS-232, RS-485 and RS-422 communication
6. Study of important features of SCADA software package
7. Study of different type of animations used in SCADA software
8. Development of GUI using different type of scripting on SCADA software
9. Interfacing of PLC with SCADA software package
10. Communication of SCADA software with Ms-excel/SQL/MS-Access
11. Interfacing of I/O modules with SCADA/ DCS package

12. Study of LAN of computer lab (to understand the network topology, network access protocol, data highway option, Ethernet, etc.)

Major Equipment:

Computers, I/O modules, PLC, SCADA software, DCS set up, PID Controller, etc.

List of Open Source Software/learning website:

http://ial-coep.vlabs.ac.in/

http://www.idc-online.com

http://www.isa.org

http://www.controleng.com/

http://literature.rockwellautomation.com/

http://www.automation.siemens.com/

http://nptel.ac.in/video.php

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161716
INDUSTRY 4.0
6th SEMESTER

Type of course: Core Engineering

Prerequisite: Sensor/ transducer, field transmitters, converters, final control element, Computer based control system architecture, Basics of Internet of Things (IoT)

Rationale: The world is at the onset of the Fourth Industrial Revolution and this revolution is very much driven by the smarts in automating decision making and processes. Advancements in IT has resulted in immense improvements in computational power across nearly all electronic devices and enhanced capabilities in connecting the dots in an increasingly networked society. Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. This course provides learners an introduction to Industry 4.0 (or the Industrial Internet), its applications in the business world. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

S. N.	Content	Total Hrs	% Weigh tage
1	Module 1: Introduction to Industry 4.0 1.1 The Various Industrial Revolutions 1.2 Digitalisation and the Networked Economy 1.3 Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 1.4 The Journey so far: Developments in USA, Europe, China and other countries 1.5 Comparison of Industry 4.0 Factory and Today's Factory 1.6 Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation	08	21
2	Module 2: Road to Industry 4.0 2.1 Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services 2.2 Smart Manufacturing 2.3 Smart Devices and Products 2.4 Smart Logistics 2.5 Smart Cities 2.6 Predictive Analytics	06	16

3	Module 3: Related Disciplines, System, Technologies for enabling Industry 4.0 3.1 Cyberphysical Systems 3.2 Robotic Automation and Collaborative Robots 3.3 Support System for Industry 4.0 3.4 Mobile Computing 3.5 Related Disciplines 3.6 Cyber Security	08	21
4	Module 4: Role of data, information, knowledge and collaboration in future organizations 4.1 Resource-based view of a firm 4.2 Data as a new resource for organizations 4.3 Harnessing and sharing knowledge in organizations 4.4 Cloud Computing Basics 4.5 Cloud Computing and Industry 4.0	08	21
5	Module 5: Other Applications and Case Studies 5.1 IIoT case studies 5.2 Case studies from students	04	10
6	Module 6: Business issues in Industry 4.0 6.1 Opportunities and Challenges 6.2 Future of Works and Skills for Workers in the Industry 4.0 Era 6.3 Strategies for competing in an Industry 4.0 world	04	11

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
07	**14**	**14**	**14**	**14**	**07**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Text Books

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", *Apress, 2016*

2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", *Springer, 2010.*

3. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing Systems" *(Springer)*

4. A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, *Wiley, 2013, ISBN-10: 111843062X*

5. A. Bagha and V. Madisetti, Cloud Computing: A Hands-on Approach, *1st edition, Universities press, 2015, ISBN-10: 8173719233.*

6. B. Evans, Beginning Arduino Programming – Writing Code for the Most Popular Microcontroller Board in the World, *1st edition, Apress, 2011, ISBN13: 9781430237778.*

7. S. Chin and J. Weaver, Raspberry Pi with Java: Programming the Internet of Things (IoT), *1st edition, McGraw Hill Publisher, 2015, ISBN-10: 0071842012.*

Reference Books:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
2. J. Chanchaichujit, A.Tan, Meng, F., Eaimkhong, S. "Healthcare 4.0 Next Generation Processes with the Latest Technologies", Palgrave Pivot, 2019.
3. F. Lamb, Industrial Automation: Hands on, 1st edition, McGraw-Hill Education, 2013, ISBN-10:0071816453
4. M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992
5. Industrial Internet Vocabulary - IIC
6. The Industrial Internet of Things Volume G1: Reference Architecture – IIC
7. Industrial Internet of Things Volume G4: Security Framework –IIC

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the drivers and enablers of Industry 4.0	
CO-2	Appreciate the smartness in Smart Factories, Smart cities, smart products and smart services	
CO-3	Outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world	
CO-4	Understand the opportunities, challenges brought about by Industry 4.0 and how organisations and individuals should prepare to reap the benefits	
CO-5	Publish and distribute Android Application	

List of Practical:

Introduction to Microcontrollers and Sensors.

Prototyping Embedded devices using Arduino/ Raspberry Pi/ BeagleBone Black/ etc. notable platforms

I/O control interface programming.

Communication protocol implementation and testing using Microcontroller.

Configuring Wired/Wireless network interface to Microcontroller and programming

Configuring cloud database management and accessing

Sensors, Gateway and Cloud interface

Data analysis from cloud and reporting

Prototyping online Components – Getting Started with an API, Writing a New API, Real Time Reactions, Other Protocols.

Major Equipment:

List of Open Source Software/learning website:

http://vlab.co.in/
www.isa.org
http://nptel.ac.in/video.php
http://www.idc-online.com/
https://www.i-scoop.eu/industry-4-0/
https://new.siemens.com/in/en/company/topic-areas/digital-enterprise.html

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170001
Semester –VII
Subject Name: Summer Internship

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
0	0	0	2	0	0	80	20	100

The duration of internship will be two weeks. It will be after completion of 6th Semester and before the commencement of Semester VII.

Following options can be opted by the students:

1. Offline internship in industry - Student is supposed to produce joining letter and relieving letter once the internship is over in case of Offline internship in any industry.
2. Online internships – with organizations /institutions those are approved /supported / recommended by the All India Council of Technical Education for Internship (like Internshala etc)
3. A Mini Project- to be carried out on some suitable topic related to respective branch. It can be small fabrication / experimental results/ simulations/ application development / Design and / or Analysis of System(s) etc. depending on the branch of the student. Preferably a single student should carry out a mini-project.

Report Submission and Evaluation Guidelines:

- Student has to prepare a detailed report and submit the report to his/her college. A copy of report can be kept in the departments for record.
- Each student must be assigned a faculty as a mentor from the college and an Industry Expert as External Guide or Industry Mentor.
- The evaluation will be of 20 marks for I component and 80 marks for V Component. I Component (20 marks) will be evaluated by the Faculty Mentor or Internal guide of the students and V Component (80 marks) will also be carried as Internal Faculty (Department/ Institute faculty) but this V Component will be evaluated by faculty member of the department / institute and nominated / appointed by the Internship Committee formed by the institute.
- The presentation by student for Internship/ Mini project should in the presence of all students is desirable.
- Student should produce successful completion certificate in case of summer internship in industry.
- The details of type of Internship carried out by student will be uploaded on the GTU PMMS portal from the available option(s) like Offline Internship, Online Internship OR Mini project and the Summer Internship report will be uploaded on the PMMS portal.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170001

Course Outcomes:

Upon completion of this course students are able to:

1. Get exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Get possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job(s).
3. Gain experience in writing Technical reports / projects and presentation of it.
4. Learn and gain exposure to the engineer's responsibilities and ethics.
5. Understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

General Guidelines for Summer Internship

Step 1: Request Letter/ Email from the Institute should go to industry to allot multiple slots of 2 weeks during summer vacation as Summer Internship period for the students. Students request letter/profile/ interest areas may be submitted to industries for their willingness for providing the internship.

Step 2: Industry will confirm the internship slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the internship themselves the confirmation letter will be submitted by the students in the office Institute through respective department. Based on the number of slots agreed to by the Industry, institute will allocate the students to the Industry.

Step 3: Students, after joining the Training at the concerned Industry / Organization, has to submit the Joining Report/ Letters / Email.

Step 4: Students are undergoing for Summer Internship at the concerned Industry / Organization. In between Faculty Member(s) has to evaluate(s) the performance of students once by visiting the Industry/Organization and Evaluation Report of the students needs to be submit in department office with the consent of Industry persons/ Trainers.

Step 5: Students will submit a training report after completion of internship.

Step 6: Training Certificate to be obtained from industry.

Step 7: List of students who have completed their internship successfully will be issued/maintained by Training and Placement Cell of the Institute.

Evaluation Rubrics

List of Documents to be prepared for Submission:

- Detail report duly signed and approved by the internal/external mentor
- Presentation softcopy approved by the internal/external mentor
- CD – Scan copy of report and presentation

Student Details												
Enrollment Number												
Student Name												
Branch												
Code and Name of the Institute												
Mentor Details	Name: Designation: Mobile No:											
Mode of Internship Carried Out	Online / Offline											
Title of the Project/ Internship carried out												
Nature of Work Carried Out	Small fabrication / experimental results/ simulations/ Application development / Design and / or Analysis of System(s) etc… Other please Specify_____											

[Company Institute letterhead]

No: Date

TO WHOM IT MAY CONCERN

This is to certify that, Mr./Mrs. _____ Enrollment No_____ Student of _____, has successfully completed a two week Internship in the field of _____ during the period of _____

During the period of his/her internship program with us, He/She had been exposed to different processes and was found sincere and hardworking.

Authorised Signature Mentor Signature

Institute Head

Evaluation Rubrics

Enrollment No: _____ **Branch:_____**

Name of the Students: _____

Date of Evaluation: _____

Internal Evaluation – 20 Marks PA(I) (To be carried out by the mentor in consultation with Industry) Minimum Passing Marks: 10					
Parameter	Excellent	Very Good	Good	Not up the level of Satisfaction	Obtained Marks
Mark range	10	09-08	07-05	Below 5	
Student regularity during the Internship period and proactiveness/responsiveness towards the given tasks **10 marks**					
Quality of the prepared report **10 marks**					
Total Marks Obtained Out of 20 PA(I)					

External Evaluation – 80 Marks ESE(V) Minimum Passing Marks: 40						
Parameter	Excellent	Very Good	Good	Average	Not up the level of Satisfaction	Obtained Marks
Mark range	20-17	16-15	14-12	11-10	Below 10	
Adequacy and Quality of the Work carried Out (**20 Marks)**						
Tools and Techniques Used and to achieve the objectives of the work (**20 Marks)**						
Work Plan and Execution and Outcome achieved (**20 Marks)**						
Quality of the report and presesentation Skill **(20 Marks)**						
Total Marks Obtained Out of 80 ESE(V)						

External Examiner Name:_____ **External Examiner Name:_____**

Signature:_____ **Signature:_____**

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171708
Semester – VII
Subject Name: Digital Signal Processing (IC)

Type of course: Core Course

Prerequisite: signals and systems, Analog signal processing, differential equations, convolution, Fourier Transforms

Rationale: It is very important to understand the signal characteristics and system behaviour when the signals are digitized. Noises from the signals can be removed by designing filters using software. So, it is very important to understand the fundamentals of processing of complex signals. This subject will provide better understanding of discrete-time and digital signal in time and frequency domain. Students will also be able to design and implement FIR and IIR filters with different structures. Students will also be introduced to digital signal processor.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**STRUCTURES FOR DISCRETE TIME SYSTEMS** Block Diagram and signal flow diagram representations of Linear Constant-Coefficient Difference equations, Basic Structures of IIR Systems, Transposed forms, Direct and cascade form Structures for FIR Systems, Effects of Co-efficient quantization	6
2	**DISCRETE FOURIER TRANSFORM : ITS PROPERTIES AND APPLICATION** **Frequency –Domain Sampling (The Discrete Fourier Transform):** frequency domain sampling and reconstruction of discrete – time signals, discrete Fourier transform (DFT), the DFT as a linear transformation, relationship of the DFT with other transformation **Properties of the DFT:** periodicity, linearity, symmetry, multiplication of two DFTs and circular convolution **Linear Filtering Methods Based on the DFT:** use of DFT in linear filtering, filtering of long data sequence; Frequency Analysis of Signals Using the DFT	8
3	**FAST FOURIER TRANSFORM** **Efficient Computation of DFT:(FFT Algorithm):** Direct computation of a DFT, divide & conquer approach to computation of DFT, radix2 and radix 4 FFT Algorithms	4

4	**Filter Design Techniques** Design of Discrete-Time IIR filters from Continuous-Time filters- Approximation by derivatives, Impulse invariance and Bilinear Transformation methods; Design of FIR filters by windowing techniques, Illustrative design examples of IIR and filters.	6

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**21**	**14**	**21**	**7**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. "Digital Signal Processing: Principles, Algorithm & Application",4th edition,Proakis, Manolakis, Proakis, Manolakis, Pearson

2. "Discrete Time Signal Processing":Oppeheim, Schafer, Buck Pearson education publication, 2nd Edition, 2003.

3. Digital Signal Processing fundamentals and applications, Li Tan , Elsevier

4. .Digital Signal Processing, S.Salivahanan, A.Vallavaraj, C.Gnapriya TMH

Course Outcome: After learning the course the students should be able to:

1. analyse the signals in both time and frequency domain
2. design FIR and IIR filters for signal pre-processing
3. implement and realize the filters using different structures.
4. explain the selection of DSP processor for signal processing applications.

List of Experiments:

1. To represent basic signals (Unit Step, unit impulse, ramp, exponential).

2. To represent sine, and cosine signals.

3. To develop program for discrete convolution.
4. To develop program for convolution without direct matlab command.
5. To develop program for discrete correlation.
6. (a) Determine the Impulse response for the system described by the second order difference equation ,$y(n) = x(n) + 0.6y(n-1) – 0.08y(n-2)$
   (b) Also obtain the Pole-Zero plot for the same and hence comment on the ROC and stability of the system.
   (c) Express following Z transform in factored form, plot its poles & zeros, and determine its ROCs.
7. To understand sampling theorem.
8. To design digital IIR filters
9. To design digital FIR filter

Design based Problems (DP)/Open Ended Problem:

1. Design a 25-tap Bandpass Filter for the following specifications:
Cut-off frequencies : 0.25pi and 0.75pi, Windowing: : Rectangular and Hamming, Order: : 25
Compare different Windowing Techniques and comment on the same.
2. Design Butterworth LPF for following specifications:
Passband Attenuation: 0.4dB, Stopband Attenuation: 35 dB,,Passband frequency : your Roll no + 400Hz,Stopband frequency : your Roll no + 800 Hz,Sampling frequency : 3000 Hz

Major Equipment:

Computers, DSP kits, Simulation software like Scilab/ Matlab

List of Open Source Software/learning website: https://nptel.ac.in/courses/117/102/117102060/

https://nptel.ac.in/courses/108/101/108101174/

https://nptel.ac.in/courses/108/106/108106151/

NPTEL Website

MIT Open Course Ware (http://ocw.mit.edu/resources)

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171710
Semester – VII
Subject Name: PROCESS DYNAMICS AND CONTROL

Type of course: Professional Elective Course-1

Prerequisite: Process Instrumentation, Process Loop Components, Control System Design

Rationale: In the process industries like petrochemical, chemical, cement, textile, power plant, pulp & paper, certain sub-processes are part of the main process stream. For continuous production, it is very much important to know the dynamic behavior of such process units and their control. The content of this subject focuses on such sub-processes and it's control.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1.	**Introduction to process control** Dynamics and stability of controlled systems. Dynamic behavior of linear and non-linear first-and second-order systems. The development of mathematical models to describe process dynamic behavior	6
2.	**The Dynamics and Control of Heat Exchangers** Basic control strategies, dynamics of the heat exchangers, response to changes in steam temperature, measurement lag and control schemes	6
3.	**The Dynamics and Control of Boilers** Boiler basic controls (safety interlocks, single element, two and three element level control, shrink, swell effect, inverse response, feed forward control of feed water, dynamic compensation, fuel–air ratio, stochiometric calculations, steam temperature and pressure control) Boiler dynamics, burner management system, boiler optimization	6
4.	**The Stability and Control of Chemical Reactors** Types of reactions and reactors (overview),factors governing the conduct of reaction, stability of reactors, time constant, effects of lag, flow control, temperature control, pH control, end point detection of continuous and batch reactors. Sequential & logic control in batch process, batch production management	6

5.	**Dynamic Behavior and Control of Distillation Column** Mass and Energy balance, column feed control, column pressure control, control of overhead and bottom composition, distillate reflux flow control. Frequency response, lag in liquid and vapor flow, concentration lag, predicting the behavior of control system	5
6.	**Unit operations in different industries** Identification and justification of unit operations used in different industries like food, pharma, paper, sugar, cement, fertilizer, Petrochemical industry with help of process flow diagram	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
14	**14**	**14**	**14**	**14**	**7**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Instrument Engineers Handbook: Process Control by Bela G Liptak , Chilton book co.
2. Process Dynamics and Control by Dale E. Seborg, John Wiley & Sons,
3. Process Instrumentation and control Handbook by Considine, Mc-Graw-Hill publication

Text Book:

1. Process Control by Peter Harroitt, Tata-McGraw Hill. Fifth ed.
2. Process Control Systems by F. G. Shinskey, Tata-McGraw Hill.
3. Chemical Process Control by George Stephonopolous, PHI
4. Computer based Industrial Control by Krishna Kant, PHI
5. Process Control: Modeling, Design and Simulation by B. Wayne Bequette, PHI

Course Outcome: After learning the course the students will be able to

CO1. Demonstrate an understanding of the fundamentals of process dynamics & its modeling and identify the linear and nonlinear behavior

CO2. Select, design and apply control strategies to control the heat exchanger, Boiler, Chemical Reactor and Distillation Column

CO3. Select pumps & compressors and apply its control strategies for process industries.

CO4 Identify and understand the unit operations used in different process industries.

CO5 Use and apply soft computing tools for the analysis of process dynamics and control.

List of Experiments:

Students are expected to perform minimum 8 experiments based on the above topics

- Modeling and Designing control strategies of a typical process
- Process simulation: using MATLAB Simulink, Simulation of different process
- Problems based on stability, frequency response etc.

Suggested Experiment list

1. Study of Dynamic behavior of 2nd order systems. (suggestion: use RLC circuit and for a given step input in voltage try to find out its second order equivalent model by observing capacitor voltage as output)
2. Study of flow control loop using PID controller
3. Study of Level Control loop using PID controller
4. Simulation study of cascade control preferably for chemical process.
5. Simulation study of feed-forward control preferably for chemical process.
6. Simulation study of ratio control preferably for chemical process.
7. Implement temperature control system with PID controller or ON OFF controller.
8. Perform system identification of first or second order system with input and output data. (Suggestion: use system identification toolbox in MATLAB/Simulink or use open source ware: SCILAB)
9. Use the in-built PID controller in PLC. Implement On/ OFF control for temperature process with PLC. (Suggestion: work on actual PLC like (SIEMENS, ABB, SCHNEIDER, DELTA etc.)

Open ended problem:

Try to obtain the mathematical mode of Tubular heat exchanger with theoretical background and chemical/mechanical engineering. Propose a control strategy for the heat exchanger. Also discuss various issues in control of the heat exchanger.

Major Equipment:

Computers, simulation software, multi loop/ single loop control system, etc.

List of Open Source Software/learning website:

https://nptel.ac.in/courses/103/104/103104050/

https://nptel.ac.in/courses/103/101/103101142/

https://nptel.ac.in/courses/103/105/103105064/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171712
Semester – VII
Subject Name: Image Processing (IC)

Type of course: Professional Elective

Rationale: Image processing has become a very important aspect in various industries ranging from process industry to medical field. This course will help to understand the fundamental concepts of image processing. Student will also learn to apply various processes on images for image understanding and analysis.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction and Digital Image Fundamentals** Types of images, Fields and applications of digital image processing, Fundamental steps, Components, Digital image fundamentals, Human visual system, Image as a 2D data, Image model, Image representation – Gray scale and Color images, Image sampling andquantization, Basic relationships between pixels.	06
2	**Image Enhancement in the Spatial Domain** Basic gray level transformations, Histogram equalization, Basics of spatial filtering, Smoothing spatial filters, Sharpening spatial filters, Combining spatial enhancement methods.	06
3	**Image Enhancement in the Frequency Domain** Preliminary concepts, Extension to functions of two variables, Image smoothing, Image sharpening, Ideal, Butterworth and Gaussian filters, Properties of 2D Fourier transform.	06
4	**Image Compression** Fundamentals of redundancies, Basic compression methods: Huffman coding, Arithmetic coding, LZW coding, Bit plane coding, Discrete cosine transform, Walsh-Hadamard transform, JPEG compression standard.	06
5	**Morphological Image Processing** Basic concepts, Erosion, Dilation, Opening, Closing, Basic morphological algorithms:	06

	Boundary extraction, Region filling, Connected components extraction, Convex hull, Gray scale morphology and its applications.	
6	**Image Segmentation** Point, line and edge detection, Thresholding, Edge linking and boundary detection, Hough transform, Thresholding: Foundation, illumination, global and adaptive thresholding, Region growing segmentation.	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**14**	**21**	**14**	**14**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: The weightage and the specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

Text Books

1. Gonzalez & Woods, ―Digital Image Processing, 3rd ed., Pearson education,2008
2. Jain Anil K., Fundamentals Digital Image Processing, Prentice Hall India,2010

Reference Books:

1. Milan Sonka, Vaclav Hlavav, Roger Boyle, ―Image Processing, Analysis and Machine Vision, 2nd ed., Thomson Learning,2001
2. Rangaraj M. Rangayyan, ―Biomedical Image Analysis, CRC Press,2005
3. Pratt W.K, ―Digital Image Processing, 3rd ed., John Wiley & Sons,2007

Course Outcome:

After learning the course the students will be able to:

CO1 compare different methods for image acquisition, storage and representation in digital devices and computers.
CO2 apply the knowledge of mathematics for digital image enhancement.

CO3 appreciate the role of image transforms in representing, highlighting, and modifying image features.
CO4 summarize different reshaping operations on the image and their practical applications.
CO5 apply various methods for image segmentation and identifying image components.

List of Experiments:

1. Introduction to Image processingtoolbox.
2. Read an 8 bit image and then apply different image enhancementtechniques:
    a. Brightnessimprovement
    b. Brightnessreduction
    c. Thresholding
    d. Negative of animage
    e. Logtransformation
    f. Power lawtransformation.
3. Implement different interpolation techniques.
4. Read an image, plot its histogram then perform histogram equalization. Comment about theresult.
5. (a) Implement gray level slicing (intensity level slicing) on the image.
    (b) Read an 8 bit image and to see the effect of each bit on theimage.
    (c) Read an image and extract 8 different planes i.e. “bit planeslicing”.
6. Implement various smoothing spatialfilters.
7. Read an image and apply (i) Gaussian 3x3 mask for burring (ii) High pass filter mask with different masks (iii) Laplacian operator with center value positive and negative.
8. Write a program to implement various low pass filters and high pass filters in frequencydomain.
9. Write a program for erosion and dilation, opening and closing using inbuilt and without inbuilt function.
10. Implement and study the effect of different masks (Sobel, Prewitt andRoberts).
11. Implement various noise models and theirhistogram.
12. Implement inverse filter and Wiener filter over image and comment onthem.
13. Implement image compression using DCT transform.

Design based Problems (DP)/Open Ended Problem:

Find out the application of image processing in automation field. Do the simulation of the application that you have identified.

Major Equipment: Computers, simulation software – MATLAB/

SciLab, etc. List of Open Source Software/learning website:

https://nptel.ac.in/courses//106/105/106105032/

https://nptel.ac.in/courses/117/105/117105079/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171714
Semester – VII
Subject Name: ADVANCE CONTROL THEORY

Type of course: Professional Elective Course

Prerequisite: Knowledge of engineering mathematics, basics of control theory and process control, simulation on matlab/ scilab or other equivalent software

Rationale: To meet the requirement of control speed and complexity, the complex system demands for modern control theories. In this subject, as the name suggest, the advance theory of control engineering and their possible applications are to be explored so that the modern control theory can be applied to improve the performance of the systems. This subject may be useful for those who aspire for the post graduation.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Discretization of continuous systems, sampling theorem, z transform, zero order hold, convert transfer function, continuous to discrete domain, mapping between s and z domain, stability criteria in z- domain. Effect of sample time on systems stability. Root locus for discrete time systems stability.	12
2	Converting of continuous time state space systems to discrete time state space, State space analysis and design of discrete time systems, stability in state space, design of state feedback controller, state observer design. Digital implementation of PID controller	06
3	Introduction to nonlinear systems. Types of common nonlinearities, Stability of nonlinear systems, describing functions analysis, limit cycles, phase plane analysis, phase trajectories.	12
4	Introduction to Multivariable Systems, interaction and decoupling, Relative Gain Array, stability of multivariable systems. Two degree of freedom controller design for SISO system in continuous and discrete domain	06

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171714

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**14**	**14**	**21**	**21**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Modern Control Engineering by K. Ogata, PHI.

2. Discrete Time Control Systems by K. Ogata, PHI.
3. Automatic Control Systems by B C Kuo, PHI.
4. Control Systems, Principles and Design by M. Gopal, MC Graw Hill, 2012.
5. Modern control systems / Richard C. **Dorf**, Robert H. **Bishop, Pearson.**

Course Outcome:

After learning the course the students should be able to:

After learning this course, the students should be able to:	
CO 1	Demonstrate an understanding of the fundamentals of advance control systems.
CO 2	Develop and use models (transfer function & state space in digital domain) of physical systems in forms suitable for use in the analysis and design of digital control systems.
CO 3	Apply relevant concepts to select and design advance control systems like multivariable control and discrite time state feedback control systems.
CO 4	Analyse nonlinear properties of systems and interprete the stability of nonlinear systems.
CO 5	Use and apply simulation tools for design & performance evaluation of advance control systems

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171714

List of Experiments:

*(Followingpracticals are recommended but they are not limited for modifications and or alterations by the faculty member/s teaching the particular subject. The use of MATLAB or SCILAB or equivalent software is suggested.***)**

1	Modeling of continuous and discrete time system using Matlab/Scilab.
2	Discretize the continuous system in to z transform using Matlab/Scilab.
3	Analysis of effect of sampling time in z transform using Matlab/Scilab/simulink.
4	Root locus analysis of control system model in z-domain using Matlab/Scilab.
5	Time Response analysis of control system in continuous and discrete domain using Matlab/Scilab.
6	State space representation of continuous system in to discrete time using Matlab/Scilab.
7	Analyze the effect of sampling on discrete time state space using Matlab/Scilab.
8	Find stability of discrete time state space model using Eigen value analysis and plot its state response using Matlab/Scilab/simulink.
9	Design state feedback controller for the discrete time state space model using Matlab/Scilab.
10	Design state observer for the discrete time state space model using Matlab/Scilab.
11	Implement discrete PID controller for the discrete time state space model using Matlab/Scilab/simulink.
12	Analyze the effect of nonlinear element on sinusoidal input using Matlab/Scilab/simulink.
13	Obtain Relative Gain Array of multivariable system using Matlab/Scilab/simulink.
14	Analyze the effect of interacting and non-interacting multivariable systems using Matlab/Scilab/simulink.

All practical can be designed in MATLAB or SCILAB ,/Proteus /Keil.

Design based Problems (DP)/Open Ended Problem:

Design 2 DOF controllers for the continuous and discrete system using Matlab/Scilab/simulink.

Major Equipment:

Educational prototype models, Computers, simulation software, microcontrollers etc.

List of Open Source Software/learning website:

http://nptel.ac.in/video.php

https://nptel.ac.in/courses/101/108/101108047/

https://nptel.ac.in/courses/108/103/108103007/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171715
Semester – VII
Subject Name: SOFT COMPUTING CONTROL

Type of course: Professional Elective Course -1

Prerequisite: Basic of process control loop, Control system design

Rationale: To meet the requirement of control complexity and speed, the soft computing base control demands for modern control theories. In this subject, theory of soft computing is to be explored so that it can be applied to improve the performance of the control systems. It can be used for non-linear control applications also. This subject may be useful for those who aspire for the post-graduation.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Introduction of fuzzy logic, Fuzzy sets, Membership functions, Fuzzification, Membership value assignment	06
2	Defuzzufication, Fuzzy Rule base, Fuzzy Inference system, Fuzzy Decision making	06
3	Fuzzy Control, Convention control systems, Fuzzy logic control vs. PID control, Stability.	06
4	Application of fuzzy logic: Power plants, Industrial Control, AC Induction motor control, Traffic control, water treatment system, Chilling systems, Washing machine Control, Fuzzy logic in DCS &PLC, Industrial Index motion control, Automatic generation control, power control, Automotive applications, Drying processcontrol.	10
5	Neuro-Fuzzy systems, Basic of neural network, Supervise neural learning, Neuro-fuzzy modeling example.	08

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171715

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**21**	**28**	**14**	**7**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Introduction of fuzzy logic using matlab, S.N. Sivananddam, S. N. Deepa, Dr. S. Sumathi, Springer Publication,2007
2. Introduction to applied Fuzzy electronics by Ahmad M. Ibrahim, Prentice-Hall ofindia.
3. Fuzzy logic for embedded systems application by Ahmad M. Ibrahim, Elsevier science, USA,2004
4. Computational Intelligence Paradigms by S. Sumathi, Surekha P. CRC press, Taylor and Francis Publication,2011.
5. Fuzzy Logic Intelligence, Control and Information by John Yen, Reza Langar, Pearson Education, 2003
6. Neural networks, fuzzy logic, and genetic Algorithms by S. Rajasekaran, G.A. VijayalakshmiPai , PHI Learning Publication,2014
7. Neuro-Fuzzy and Soft computing, A computational Approach to learning and machine intelligence by J. Jang, T. Sun and E. Mizutani, Prentice Hall Publication,2011.
8. Introduction to fuzzy sets, fuzzy logic & Fuzzy control systems by G. Chen and T. Pham, CRC Press, 2001.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171715

Course Outcome:

After learning this course, the students should be able to:

CO1 Understand concept of fuzzy logic.

CO2 Design Fuzzy logic control and its stability analysis.

CO3 Learn programming of fuzzy logic.

CO4 Design and utilization of fuzzy logic controller for various industrial applications.

CO5 Understanding of neural network and neuro fuzzy system.

List of Experiments:

1. Study of fuzzy logic tool in any technical programminglanguage.
2. Study of membershipfunctions.
3. Study of defuzzificationmethods.
4. Study of Fuzzy PIDcontrol.
5. Study and design fuzzy logic control for levelcontrol.
6. Study of fuzzy base washing machinecontrol.
7. Study of temperature control inshower.
8. Study of temperature control inreactor.
9. Study of motor control using LabVIEW base fuzzylogic.
10. Study of fuzzy control inPLC.

Design based Problems (DP)/Open Ended Problem: Fuzzy logic related applications.
Major Equipment: Computers, Fuzzy logic software, PLC, Technical software as Matlab, LabVIEW, Scilab etc.

List of Open Source Software/learning website:
https://nptel.ac.in/courses/106/105/106105173/
https://nptel.ac.in/courses/127/105/127105006/
https://onlinecourses.nptel.ac.in/noc20_cs17/preview

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171716
Semester – VII
Subject Name: PYTHON FOR ENGINEERS

Type of course: Professional Elective Course-3

Prerequisite: Fundamental knowledge about computer systems and positive aptitude to learn programming, Basic knowledge of C Programming.

Rationale: Python is general purpose programming language becomes very popular in last decade. In this age, engineers must learn Python Programming to build applications in their core domain. Python is becoming popular in artificial intelligence and machine learning. MicroPython is sub-set of Python Programming useful to port in hardware for embedded and IoT applications

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1.	**Introduction, Data Types and Operators:** Installation and working with Python, Variables and data types in python, Perform computations and create logical statements using Python's operators: Arithmetic, Assignment, Comparison, Logical, Membership, Identity, Bitwise operators, list, tuple and string operations	06
2	**Python Decision making and Loops:** Write conditional statements using If statement, if ...else statement, elif statement and Boolean expressions, While loop, For loop, Nested Loop, Infinite loop, Break statement, Continue statement, Pass statement, Use for and while loops along with useful built-in functions to iterate over and manipulate lists, sets, and dictionaries. Plotting data, Programs using decision making and loops.	08
3	**Python Functions and Modules:** Defining custom functions, Organizing Python codes using functions, Create and reference variables using the appropriate scope, Basic skills for working with lists,	08

	tuples, work with dates and times, get started withdictionaries, Importing own module as well as external modules, Programming using functions, modules and external packages	
4	**Python File Operations:** An introduction to file I/O, use text files, use CSV files, use binary files, Handle a single exception, handle multiple exceptions, Illustrative programs, Exercises	**06**
5	**MicroPython:** Introduction, main difference between MicroPython and Python, Installation of MicroPython on Hardware, MicroPython libraries, GPIO programming on MicroPython Hardware, Sensor Programming using MicroPython	**08**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**25**	**15**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. "Introduction to Phython for Science and Engineering" by David J. Pine, CRC Press.
2. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India
3. Python Programming Fundamentals- A Beginner's Handbook by NischaykumarHegde
4. Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication
5. Introduction to Python for Engineers and Scientists, By. Sandeep Nagar, Apress
6. MicroPython for the Internet of Things (A Beginner's guide to programming with Python on microcontrollers) By. Charles Bell, Apress

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171716

Course Outcome:

After learning the course the students should be able to:

After learning this course, the students should be able to:	
CO 1	To test and debug code written in python
CO 2	To create applications using Python Programming
CO 3	To perform file operations to read and write data in files
CO 4	To write programs for general purpose I/O devices using MicroPython

List of Experiments:

1	Write Python programs to understand control structures
2	Write Python programs to understand list and tuples
3	Use conditional statements and loops in Python programs
4	Write python programs to create functions and use functions in the program
5	Import module and use it in Python programs
6	Write python program to plot data using PyPlot
7	To become familiar with MicroPython and NodeMCU. Configure NodeMCU for MicroPython
8	Write program in MicroPython to send digital data on GPIO pins of NodeMCU and glow LED connected with NodeMCU or any other MicroPython supported board.
9	Connect Digital/Analog I/O module with NodeMCU and write program to display temperature in MicroPython.
10	Connect NodeMCU with withWiFi Access Point and transmit data from NodeMCU to Cloud. Connect Digital/Analog I/O module with NodeMCU and send temperature and light data on cloud (Thingspeak, Firebase or any other cloud service)

Major Equipment:

- NodeMCU boards or any other microcontroller board supporting MicroPython firmware
- Digital analog Input Output boards consisting LEDs, Switches, LDR, Temperature sensor, POT

List of Open Source Software/learning website:

- NPTEL Video lecture on Python Programming
- https://www.coursera.org/learn/python-programming
- https://nptel.ac.in/courses/106/106/106106212/
- https://nptel.ac.in/courses/115/104/115104095/
- Python Software
- Turtle - https://docs.python.org/2/library/turtle.html
- PyLab - https://scipy.github.io/old-wiki/pages/PyLab
- Anaconda software

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171717
Semester – VII
Subject Name: ROBOTIC ENGINEERING

Type of course: Professional Elective Course

Prerequisite: Sensor/ Transducer, Fundamental of engineering mechanics, Control systems design

Rationale: In near future, robots will be used widely in the fields of manufacturing, medicine, search and rescue, service, and entertainment. So, it is very much important to teach robotics as the synergistic integration of mechanics, electronics, controls, and computer science. This subject is intended to make student aware with basics of robot sensors, controls and transformations along with essential kinematics and dynamics

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1.	**Basic Concepts** Definition and origin of robotics, different types of robotics, various generations of robots, degrees of freedom, Asimov‘s laws of robotics, dynamic stabilization of robots.	06
2	**Power Sources** Hydraulic, pneumatic and electric drives, determination of HP of motor and gearing ratio, variable speed arrangements, path determination, micro machines in robotics.	06
3	**Manipulators, Actuators and Grippers** Construction of manipulators – manipulator dynamics and force control, electronic and pneumatic manipulator control circuits, end effectors, various types of grippers – design considerations.	06
4	**Kinematics and Path Planning** Solution of inverse kinematics problem, multiple solution Jacobean work envelop, hill	06

	climbing techniques, introduction to robot programming languages.	
5	**Sensors and Intelligent Robots** Introduction to robotic sensors, vision systems, Range detectors, assembly aid devices, force and torque sensors, machine vision, ranging, laser, acoustic, magnetic, fiber optic and tactile sensors.	06
6	**Case Studies** Multiple robots, machine interface, robots in manufacturing and non-manufacturing applications, robot cell design, selection of robot.	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
7	**14**	**14**	**14**	**14**	**7**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Text Books:

1. Robot Modeling and Control *by* Spong, M.W., Hutchinson, H., &Vidyasagar, M., *John Wiley (Wiley India Ed.),* 2006, ISBN-13: 978-0471649908
2. Robotics Engineering – An integrated approach *by* Klafter R.D., Chimielewski T.A., Negin M., *Prentice Hall of India, 1994,* ISBN-13: 978-0134687520
3. Introduction to Robotics, by SAHA, *Tata McGraw-Hill Education, 2008,* ISBN 9781259083204
4. Fundamental of Robotics Analysis and control: by Robert J. Schilling, *Prentice Hall, 1996,* ISBN-13: 978-0133444339
5. Robotics Technology and Flexible Automation, by S. R. Deb, Sankha Deb, 2010 McGraw Hill, 2nd edition, 2010, ISBN: 9780070077911
6. Robotics and Image processing by P.A. Janakiraman, *Tata McGraw-Hill, 1995,* ISBN 9780074621677

7. Robotics and Control by R. K. Mittal, I. J. Nagrath, Tata-Mcgraw Hill, 2003

Reference Books:

1. Control in Robotics and Automation: Sensor Based Integration (Engineering) B. Ghosh, T. J. Tarn, Ning Xi, Academic Press, ISBN: 978-0122818455
2. Robots and manufacturing Automation by C Ray Asfahl, John Wiley, 1992, ISBN: 978-0-471-55391-5
3. Introduction to Robotics by McKerrowPhillip.John, Addison Wesley, Australia, 1991, ISBN 13: 9780201182408.
4. Principles of Robot Motion - Theory, Algorithms and Implementation (OIP) by Howie Choset, Kevin M Lynch , Seth Hutchinson , George Kantor, MIT Press, ISBN-13: 978-0262033275
5. Robotics, Vision and Control: Fundamental Algorithms in MATLAB by Peter Corke, Springer pub, 1st ed. 2011, ISBN-13: 978-3642201431

Course Outcome:

After learning the course the students should be able to:

After learning this course, the students should be able to:

CO 1	To understand the mathematics of rigid motions, rotations, translations, velocity kinematics related to robotic application
CO 2	To understand dynamics of robotic system and design multivariable controller accordingly
CO 3	evaluate the various parts of mechanical and electronic system of robots
CO 4	Apply knowledge of sensors to design intelligent robot for specific application
CO5	To be familiar with computer vision, visual servo control problems and industrial application

List of Experiments:

(Followingpracticals are recommended but they are not limited for modifications and or alterations by the faculty member/s teaching the particular subject.

1. Study different drivers for robotic arms.
2. To simulate simple robotic system using Matlab/ Msc Adam software
3. To study image processing system for robotics system
4. Matlab program for simple and inverse kinematics of simple robot configuration
5. To simulate joint torque control of manipulator
6. To model the robot dynamics using Euler-Langrangian method and to simulate the same.
7. To study feedback control of robot manipulator
8. To study adaptive control of robot manipulator
9. To study different methods of speed control of dc Motor.
10. To study speed control of stepper motor using microcontroller.
11. To study robotic programming language like AL and AML.

Design based Problems (DP)/Open Ended Problem:

Case study of one of the industrial robot or manufacturing robot

Major Equipment:

Robotic kits, Sensors, Computers, open source software, etc.

List of Open Source Software/learning website:

https://nptel.ac.in/courses/112/105/112105249/

https://nptel.ac.in/courses/107/106/107106090/

https://nptel.ac.in/courses/112/101/112101099/

http://nptel.ac.in/video.php

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171718
Semester – VII
Subject Name: POWER PLANT INSTRUMENTATION

Type of course: Professional Elective Course

Prerequisite: Fundamental of Electrical Engineering, Measurements and Sensors

Rationale: The course is designed to give knowledge of various types of power plants and related instrumentation system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1.	Introduction: Various sources of Electrical Energy, Non-Conventional and Conventional Energy Sources, Importance of Instrumentation and control in power generation, piping and instrumentation diagrams.	**04**
2	Instrumentation and control in water circuit: boiler feed water circulation, measurements, controls, impurities in water and steam. Instrumentation and control in air-fuel circuit: measurements, controls, analytical measurements.	**08**
3	Turbine monitoring and control: classification of turbines, instrumentation and control points of view, principal parts of turbines, turbine steam inlet system, turbine measurements, turbine control system, lubrication for turbo-alternator, turbo alternator cooling system.	**08**
4	Basic principles of a nuclear plant. Nuclear power plant training simulator project. Design concepts of instrumentation and control of CWR, PWR and BWR reactors (different examples).Operator/Plant communication systems, main control systems, safety and safety related systems.	**08**
5	Role of Instrumentation in hydroelectric power plant. Regulation and monitoring of voltage and frequency of output power. Pollution and effluent monitoring and control. Energy management. Electrical substation controls. Plant safety and	**08**

	redundancies of non-conventional power plants	

Demonstration of various instrumentation system should be given during filed visit of Power Plant.

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**15**	**25**	**10**	**05**	**05**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

- K. Krishnaswamy, M. PonniBala, "Power Plant Instrumentation", PHI Learning Private limited, New Delhi, 2011.
- David Lindsley, "Power Plant Control and Instrumentation, The Control of Boilers and HRSG systems", IEE Control Engineering Series 2000.
- Philip Kiameh, "Power Plant Instrumentation and Controls", McGraw Hill Education, 2014.
- Singh S K, "Industrial Instrumentation and control" Tata- McGraw-Hill Publishing Company. 2009.
- Nuclear power plant instrumentation and control, A guidebook, International atomic energy agency Vienna, 1984(online resource).
- Black & Veatch, "Power plant Engineering", CBS Publisher, 2005
- El-Wakil, M.M., "Power plant Technology", McGraw-Hill Book Co, 2002
- Nag, P.K., "Power plant engineering", Tata MacGraw Hill, 2008

Course Outcome:

After learning the course the students should be able to:

After learning this course, the students should be able to:	
CO 1	Analyze Instrumentation related to various power plants

CO 2	Identify Instrumentation in water circuits and turbine monitoring system in power plants
CO 3	Identify elements and their functions and operations of nuclear power plants.
CO 4	Understand role of Instrumentation in Power plants
CO 5	Design various simulation and sensor control system used in power plant

Suggested Experiments/Tutorial

1. Explain the block diagram and working of thermal power plant.
2. Explain the block diagram and working of hydro power plant.
3. Explain the block diagram and working of nuclear power plant.
4. Explain the block diagram and working of solar power plant.
5. Explain the working of wind power plant.
6. Write notes on importance of instrumentation in power generation.
7. Compare thermal power plant with nuclear power plant.
8. Compare hydel power plant with thermal power plant.
9. What are the factors to be considered while selecting the power plant.
10. What is co-generation? Explain in detail.
11. Brief about analysis of impurities in feed water and steam and design suitable lab experiment using impurities sensor and micro controller
12. Explain about (a) Dissolved oxygen analyzer (b) Flue gas Oxygen analyzer and design system to measure oxygen, Carbon dioxide using Gas sensor and micro controller
13. Explain in detail shell temperature monitoring and control
14. Describe in detail about cooling system used in thermal power plant
15. Describe in detail about interlocks in boiler.
16. Discuss various combustion control systems used in power plants

Design based Problems (DP)/Open Ended Problem:

Simulation and Design of Power plant system on simulation software like SCADA

Design Dust monitoring system using controller and LabVIEW

Design Gas sensing System of various gases like CO2, O2, NO using controller and LabVIEW Simulation of intelligent control strategies in instrumentation, SCADA

Major Equipment/Field Visit

Visit of Thermal and Nuclear Power plant,Hydro Power station,Power distribution System

List of Open Source Software/learning website:

https://nptel.ac.in/courses/112/107/112107291/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171719
Semester – VII
Subject Name: INSTRUMENTATION FOR AGRICULTURE AND FOOD PROCESSING

Type of course: Open Elective

Prerequisite: Fundamental knowledge of sensors & transducers, Basic concept of SCADA, PLC and DCS systems

Rationale: Agricultural industries are mostly dependent on nature behavior. To avoid crop failure, increasing crop quantity and quality, protecting crop, etc is a big challenge for farmers as well as for agro industries. There for it will be very appropriate to provide knowledge of a automation and sensing technology associated with agriculture and food processing plants/ systems to instrumentation and control engineers.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Necessity of instrumentation & control for agriculture and food processing requirement, remote sensing, biosensors in agriculture, standards for food quality. Guidelines and regulations for Industries by Food Safety and Standards Authority of India (FSSAI)	**08**
2	Application of SCADA for DAM parameters & control, Irrigation canal management up- stream & down - stream control systems, Water distribution and management control, Auto drip irrigation systems	**04**
3	Automation in earth moving equipments & farm equipments, application of SCADA & PLC in packing industry and cold storage systems, implementation of hydraulic, pneumatic & electronics control circuits in harvesters cotton pickers, tractor etc.	**08**
4	Green houses & instrumentation: ventilation, cooling & heating, wind speed, temperature & humidity, rain gauge, carbon dioxide enrichment measurement & control. Leaf area length evaportranspiration, temperature, wetness & respiration measurement & data logging, electromagnetic radiations photosynthesis, infrared & UV bio sensor methods in agriculture, agro-metrological instrumentation weather stations	**04**

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171719

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
7	14	14	14	14	7

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Text Books:

1. Industrial Instrumentation by D. Patranabis, Tata Mcgraw Hill pub
2. Process control and instrumentation technology by C.D. Johnson, 7th edition, Pearson education
3. Process Instrumentation and control handbook by Considine D. M., McGraw Hill pub.
4. Mineral Processing Technology by Wills B.A., Pergamon Press, 4th Ed.
5. G.S. Sawhney ―Non-Conventional Energy Resources, PHI Learning Private Limited, 1st ed., 2012
6. Food Safety Management Systems (FSMS) Guidelines Issued by FSSAI

Reference Books:

1. Instrumentation Engineers Handbook- Process measurement volume I and Process control volume II, by B.G.Liptak, Chilton Book Company, 2001

Course Outcome:

After learning this course, the students should be able to:

CO1. Characterize problems and possible technological solution of agro industries.
CO2. Familiarize with current literature, research in agricultural instrumentation
CO3. Analyze and design of automation system by evaluating agricultural parameter measurement constraint.

List of Experiments:

1. To test soil pH, conductivity, resistivity, temperature, moisture and salinity
2. To study instrumentation set up for sugar plant
3. To study flow diagram of fermenter and control (Batch process)
4. To study pesticides manufacturing process and control
5. To study flow diagram of dairy industry & confectionary industry and instrumentation set up
6. To study juice extraction control set up.

7. To study application of SCADA for DAM and irrigation system.
8. To study automation in farm equipment.
9. To study instrumentation and control in Green house
10. To study different bio sensors used in agro automation.

Design based Problems (DP)/Open Ended Problem:

Industrial visit of any Food processing/ Agro plant

Major Equipment:

Sensors, SCADA software, Computers, etc.

List of Open Source Software/learning website:

http://nptel.ac.in/video.php

https://nptel.ac.in/courses/126/105/126105011/

https://nptel.ac.in/courses/126/105/126105009/

https://nptel.ac.in/courses/126/105/126105013/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171720
Semester – VII
Subject Name: AUTOMOTIVE INSTRUMENTATION

Type of course: Open Elective II

Prerequisite: Sensor/ Transducer, Fundamental of engineering mechanics, Control systems design

Rationale: The automobiles are getting converted from mechanical system to highly modernized Electro-mechanical systems and from driver to driverless vehicle. The manufacturers of automobiles are increasing usage of sensors and control system to improve safety measures and also to increase comfort of users. This subject is intended to make student aware with sensors and other technologies used in modern automobiles

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1.	**Introduction of automobile system** Current trends in automobiles with emphasis on increasing role of electronics, sensors and software, overview of generic automotive control ECU functioning, overview of typical automotive subsystems and components, AUTOSAR.	06
2	**Vehicle power train and motion control** Electronic transmission control, adaptive power Steering, adaptive cruise control, safety and comfort systems, anti-lock braking, traction control and electronic stability, active suspension control.	06
3	**Active and passive safety system** Body electronics including lighting control, remote keyless entry, immobilizers etc., electronic instrument clusters and dashboard electronics, aspects of hardware design for automotive including electro-magnetic interference suppression, electromagnetic compatibility etc., (ABS) antilock braking system, (ESP) electronic stability program, air bags	06

4	**System design and energy management** BMS (battery management system), FCM (fuel control module),principles of system design, assembly process of automotives and instrumentation systems	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
7	**14**	**14**	**14**	**14**	**7**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Text Books:

1. Understanding Automotive Electronics by William B. Ribbens, Butterworth Heinemann Woburn, 6th ed., 2003
2. Sensors Applications, Sensors for Automotive Technology by Jiri Marek, Hans Peter Trah, Wiley, 1st Edition
3. U.Kiencke, and L. Nielson, *Automotive Control Systems*, Springer Verlag Berlin, 2000

Reference Books:

1. Automotive Electrical Equipment by Young A.P., Griffiths, ELBS & New Press, 1999.
2. Automotive computers and control system by Tom Weather Jr. &Cland C. Hunter, Prentice Hall Inc., New Jersey.
3. Automobile Electrical Equipment by Crouse W.H., McGraw Hill Co. Inc., New York, 1995.
4. Understanding Automotive Electronic by Bechhold, SAE, 1998.
5. Automotive Hand Book by Robert Boshe, Bentely Publishers, 5th ed. Germany, 2005.

Course Outcome:

After learning this course, the students should be able to:

CO 1 Evaluate the sensor and measuring system of automobile.

CO 2 Acquire knowledge of various automotive standards and Protocols.

CO 3 Design the basic modeling and control scheme for automotive systems.

List of Experiments:

(Followingpracticals are recommended but they are not limited for modifications and or alterations by the faculty member/s teaching the particular subject.

1. Study of speedometer, Tachometer, Odometer, Trip odometer
2. Study of battery/ charging system lamp, low oil pressure lamp, airbag lamp
3. Study of oil pressure gauge and coolant temperature gauge
4. Study of hand-brake lamp, door ajar lamp, high beam lamp, malfunction indicator lamp/ check engine lamp
5. Study of fuel gauge and low fuel lamp
6. Study of hand brake indicator, turn light and engine service indicator
7. Study of wheel balancing instruments
8. Study of automatic vehicular washing system
9. Study of electronic engine management system
10. Study of CAN protocol.
11. Study of safety and security systems of vehicle
12. Study of heating and air-conditioning system of vehicle.

Design based Problems (DP)/Open Ended Problem:

1. Simulation of control strategy of any autonomous vehicle.
2. Design PLC based/ micro-controller based automatic control system for different systems of vehicle.

Major Equipment:

Computers, transducers for automotive applications, simulation software, etc.

List of Open Source Software/learning website:

https://onlinecourses.nptel.ac.in/noc20_de06/preview

http://nptel.ac.in/video.php

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (IC)
Subject code : 3181701
Semester – VIII
Subject Name: Internship/Project

Type of course: Project work and internship in industry

Prerequisite: Instrumentation and Control Engineering (Basic science, Engineering Science and core courses), Effective Technical Communication and Design Engineering

Rationale: To enhance employability skills of the students; Industrial Internship or Project work is required. It provides practical experience in a field of Instrumentation and Control Engineering and help to reinforce theoretical knowledge gained in different courses to solve real life challenges or industrial needs.
Note: Student must submit a SoP (Statement of Purpose) to the department within 15 days of the commencement of the semester and get the approval of the project title/internship.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
0	0	24	12	0	0	100	100	200

Content: Final semester of Instrumentation and Control Engineering is dedicated to industry relevant project or Industrial internship for minimum 12 weeks.

Project work (Major): Students have to undertake a minimum 12 weeks Industry defined project work in field of instrumentation and control engineering, which will help them test their theoretical knowledge gained in earlier semesters. The Project work will enhance their capacity to undertake real-life instrumentation, control and automation engineering challenges and solve them. This will be helpful to various industries in upgrading automation, building smart cities and green technologies, applying IOT in automation & Energy conservation.

Industrial Internship: Minimum 12 weeks in an Industry to get exposure to the practical aspects of the Instrumentation and Control Engineering. During Industrial Internship Students may be encouraged to take up projects which are aimed at providing solutions by utilizing concept of Instrumentation and Control, Automation to address problems related to societal needs, improving efficiency in rural India, green technologies, utilizing non-conventional energy sources & smart cities along with all process industries. In addition, the student may also work on a specified task or project which may be assigned to him/her by industry mentor or faculty. The outcome of the Industrial Internship should be presented in the form of a report.

Guidelines for Industrial Internship:

1. To expose students to the industry environment.
2. To create competent professionals for the industry.
3. To provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
4. To work on a problem assigned by a mentor at industry, prepare action plan and complete within time limit.

5. Exposure to the current technological developments relevant to the subject area of Internship.
6. Learn to apply the technical knowledge in real industrial situations.
7. To learn, create/prepare report for Project/Framework/research as used in industry with productive (Data in a concise form) and efficient way (with action resolution).
8. To explore possibilities of patent or research paper publications.
9. Expose students to the engineer's responsibilities and ethics.
10. To become familiarize with various materials, processes, products and their applications along with relevant aspects of quality control.
11. To strengthen industry-institute linkage and increase employability of the students.
12. Students must be able to appraise the importance of an individual / team for effective execution.

OR

Guidelines for project work (Major):

1. Do literature Survey, Industrial Survey and study relevant published literature related to project.
2. Do patent search analysis and submit PSAR (Patent Search Analysis Report)
3. Design algorithm/circuit/configuration for the project and analyse/verify through simulations software.
4. Decide implementation method and list components or parts required.
5. Point out practical difficulties faced during implementations and device to solve them.
6. Iterate design if feasible to obtain better results.
7. Optimize the project design in terms of cost, area, power, computation complexity etc.
8. Compare results of projects with other similar design specifications.
9. The project work can be a simulation of circuits/systems or hardware based on the area and the complexity of the work involved.
10. If it contains the only simulation, it shall be comprehensive. The team is expected to know the various aspects of simulation techniques in detail. The team shall explain the results obtained, in fact with all the elements and different cases.
11. Prepare project report and do presentation before department project committee.
12. Conclude the project work and suggest future work.
13. Intermediate and final seminar in presence of department project committee for review of the work done
14. To explore possibilities of patent or research paper publications

Course Outcomes:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Undertake problem identification, formulation and solution	20%
CO-2	Design engineering solutions to complex problems utilising a systematic approach and team work	30%
CO-3	Communicate with industry personals & Automation experts at large in written and oral forms	20%

CO-4	Demonstrate the knowledge and understanding of engineering principles, management principles, leadership, and entrepreneurship skills and apply them to the assigned project	15%
C0-5	Students can determine the social, health, environment, safety and ethical practices during the project.	15%

References:

- AICTE Model curriculum
- AICTE Internship Policy: https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf