VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRICAL ENGINEERING

B. Tech Electrical and Electronics Engineering

(B.Tech EEE)

Curriculum

(*2021-2022 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF ELECTRICAL ENGINEERING

To be a leader for academic excellence in the field of electrical, instrumentation and control engineering imparting high quality education and research leading to global competence for the societal and industrial developments.

MISSION STATEMENT OF THE SCHOOL OF ELECTRICAL ENGINEERING

M1: Impart high quality education and interdisciplinary research by providing conducive teaching learning environment and team spirit resulting in innovation and product development.

M2: Enhance the core competency of the students to cater to the needs of the industries and society by providing solutions in the field of electrical, electronics, instrumentation, and automation engineering.

M3: Develop interpersonal skills, leadership quality and societal responsibility through ethical value-added education.

B. Tech Electrical and Electronics Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The school of Electrical Engineering has established and sustained a well-defined set of educational objectives and preferred program outcomes. Educational objectives of the program satisfy to the requirements of the stakeholders such as students, parents, employers, alumni, faculty etc. The Program Educational Objectives (PEOs) are as follows.

PEO-1: Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems in electrical engineering and allied disciplines.

PEO-2: Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.

PEO-3: Graduates will function in their profession with social awareness and responsibility.

PEO-4: Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.

PEO-5: Graduates will be successful in pursuing higher studies leading to careers in engineering, management, teaching, and research.

B. Tech Electrical and Electronics Engineering

PROGRAMME OUTCOMES (POs)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability attitude and behaviour that students acquire through the program.

NBA has defined the following twelve POs for an engineering graduate. These are in line with the Graduate Attributes as defined by the Washington Accord:

PO_01: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO_02: Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO_03: Design / Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO_04: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems:

- that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline as against problems given at the end of chapters in a typical text book that can be solved using simple engineering theories and techniques
- that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions
- that require consideration of appropriate constraints / requirements not explicitly given in the problem statement such as cost, power requirement, durability, product life, etc.
- which need to be defined (modelled) within appropriate mathematical framework

- that often require use of modern computational concepts and tools, for example, in the design of an antenna or a DSP filter.

PO_05: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO_06: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO_07: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO_08: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO_09: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO_10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO_11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO_12: Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

B. Tech Electrical and Electronics Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of B. Tech. (Electrical and Electronics Engineering) programme, graduates will be able to

- PSO1: Analyze and design electrical and electronics systems for societal and industrial needs.

- PSO2: Design power systems network, power electronic circuits, electric drives and develop control strategies by considering economic and environmental constraints.

- PSO3: Apply and implement intelligent systems using modern tools for electrical engineering applications.

CREDIT INFO		
S.no	**Catagory**	**Credit**
1	Foundation Core	51
2	Foundation Core - Non Graded	2
3	Discipline-linked Engineering Sciences	10
4	Discipline Core	51
5	Discipline Elective	15
6	Projects and Internship	9
7	Open Elective	15
8	Non-graded Core Requirement	11
Total Credits		151

Foundation Core								
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**Credit**
1	BCHY101L	Engineering Chemistry	Theory Only	1.0	3	0	0	3.0
2	BCHY101P	Engineering Chemistry Lab	Lab Only	1.0	0	0	2	1.0
3	BCSE101E	Computer Programming: Python	Embedded Theory and Lab	1.0	1	0	4	3.0
4	BCSE103E	Computer Programming: Java	Embedded Theory and Lab	1.0	1	0	4	3.0
5	BECE101L	Basic Electronics	Theory Only	1.0	2	0	0	2.0
6	BECE101P	Basic Electronics Lab	Lab Only	1.0	0	0	2	1.0
7	BEEE101L	Basic Electrical Engineering	Theory Only	1.0	2	0	0	2.0
8	BEEE101P	Basic Electrical Engineering Lab	Lab Only	1.0	0	0	2	1.0
9	BENG101L	Technical English Communication	Theory Only	1.0	2	0	0	2.0
10	BENG101P	Technical English Communication Lab	Lab Only	1.0	0	0	2	1.0
11	BENG201P	Technical Report Writing	Lab Only	1.0	0	0	2	1.0
12	BFLE200L	Foreign Language	Theory Only	1.0	2	0	0	2.0
13	BHSM200L	HSM Elective	Theory Only	1.0	3	0	0	3.0
14	BMAT101L	Calculus	Theory Only	1.0	3	0	0	3.0
15	BMAT101P	Calculus Lab	Lab Only	1.0	0	0	2	1.0
16	BMAT102L	Differential Equations and Transforms	Theory Only	1.0	3	1	0	4.0
17	BMAT201L	Complex Variables and Linear Algebra	Theory Only	1.0	3	1	0	4.0
18	BMAT202L	Probability and Statistics	Theory Only	1.0	3	0	0	3.0
19	BMAT202P	Probability and Statistics Lab	Lab Only	1.0	0	0	2	1.0
20	BPHY101L	Engineering Physics	Theory Only	1.0	3	0	0	3.0
21	BPHY101P	Engineering Physics Lab	Lab Only	1.0	0	0	2	1.0
22	BSTS101P	Quantitative Skills Practice I	Soft Skill	1.0	0	0	3	1.5
23	BSTS102P	Quantitative Skills Practice II	Soft Skill	1.0	0	0	3	1.5

24	BSTS201P	Qualitative Skills Practice I	Soft Skill	1.0	0	0	3	1.5
25	BSTS202P	Qualitative Skills Practice II	Soft Skill	1.0	0	0	3	1.5

Foundation Core - Non Graded								
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**Credit**
1	BENG101N	Effective English Communication	Lab Only	1.0	0	0	4	2.0

Discipline-linked Engineering Sciences										
sl.no	**Course Code**	**Course Title**	**Course Type**	**Ver**	**L**	**T**	**P**	**J**	**C**	**Pre req.**
1	BEEE201L	Electronic Materials	Theory Only	1.0	3	0	0	0	3.0	-
2	BEEE202L	Electromagnetic Theory	Theory Only	1.0	2	1	0	0	3.0	-
3	BEEE203L	Circuit Theory	Theory Only	1.0	3	1	0	0	4.0	Basic Electrical Engineering

Discipline Core									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Ver**	**L**	**T**	**P**	**C**	**Pre req**
1	BEEE204L	Signals and Systems	Theory Only	1.0	2	1	0	3.0	Differential Equations and Transforms
2	BEEE205L	Electronic Devices and Circuits	Theory Only	1.0	2	0	0	2.0	Basic Electronics
3	BEEE205P	Electronic Devices and Circuits Lab	Lab Only	1.0	0	0	2	1.0	Basic Electronics
4	BEEE206L	Digital Electronics	Theory Only	1.0	3	0	0	3.0	Basic Electronics
5	BEEE206P	Digital Electronics Lab	Lab Only	1.0	0	0	2	1.0	Basic Electronics
6	BEEE207L	Electrical Machines	Theory Only	1.0	3	0	0	3.0	Basic Electrical Engineering, Electromagnetic theory
7	BEEE207P	Electrical Machines Lab	Lab Only	1.0	0	0	2	1.0	Basic Electrical Engineering, Electromagnetic theory
8	BEEE208L	Analog Electronics	Theory Only	1.0	3	0	0	3.0	Electronic Devices and Circuits
9	BEEE208P	Analog Electronics Lab	Lab Only	1.0	0	0	2	1.0	Electronic Devices and Circuits
10	BEEE301L	Power Electronics	Theory Only	1.0	3	0	0	3.0	Electronic Devices and Circuits, Circuit Theory
11	BEEE302L	Digital Signal Processing	Theory Only	1.0	3	0	0	3.0	Signals and Systems
12	BEEE302P	Digital Signal Processing Lab	Lab Only	1.0	0	0	2	1.0	Signals and Systems
13	BEEE303L	Control Systems	Theory Only	1.0	3	0	0	3.0	Basic Electrical Engineering, Differential Equations and Transforms
14	BEEE303P	Control Systems Lab	Lab Only	1.0	0	0	2	1.0	Basic Electrical Engineering, Differential Equations and Transforms
15	BEEE304L	Power Systems Engineering	Theory Only	1.0	3	1	0	4.0	Circuit Theory
16	BEEE305L	Measurements and Instrumentation	Theory Only	1.0	2	0	0	2.0	Circuit Theory
17	BEEE305P	Measurements and Instrumentation Lab	Lab Only	1.0	0	0	2	1.0	Circuit Theory
18	BEEE306L	Power Systems Analysis	Theory Only	1.0	3	0	0	3.0	Power Systems Engineering
19	BEEE306P	Power Systems Analysis Lab	Lab Only	1.0	0	0	2	1.0	Power Systems Engineering
20	BEEE307L	Electric Drives	Theory Only	1.0	3	0	0	3.0	Electrical Machines, Power Electronics
21	BEEE307P	Power Electronics and Drives Lab	Lab Only	1.0	0	0	2	1.0	Electrical Machines, Power Electronics

22	BEEE308L	Communication Systems	Theory Only	1.0	3	0	0	3.0	Signals and Systems, Analog Electronics
23	BEEE309L	Microprocessors and Microcontrollers	Theory Only	1.0	3	0	0	3.0	Digital Electronics
24	BEEE309P	Microprocessors and Microcontrollers Lab	Lab Only	1.0	0	0	2	1.0	Digital Electronics

	Discipline Elective								
No	**Course Code**	**Course Title**	**Course Type**	**Ver**	**L**	**T**	**P**	**C**	**Pre req**
1	BEEE001L	Machine Learning	Theory Only	1.0	3	0	0	3.0	Probability and Statistics
2	BEEE002L	Artificial Intelligence	Theory Only	1.0	3	0	0	3.0	Probability and Statistics
3	BEEE003L	Electrical Machine Design	Theory Only	1.0	2	1	0	3.0	Electrical Machines
4	BEEE004E	VLSI Design	Embedded Theory and Lab	1.0	2	0	2	3.0	Digital Electronics
5	BEEE005L	Engineering Optimization	Theory Only	1.0	2	1	0	3.0	-
6	BEEE006L	Embedded Systems Design	Theory Only	1.0	3	0	0	3.0	Microprocessor and Microcontroller
7	BEEE007L	Digital Image Processing	Theory Only	1.0	3	0	0	3.0	Digital Signal Processing
8	BEEE008L	Bio-Medical Instrumentation	Theory Only	1.0	3	0	0	3.0	-
9	BEEE009L	Design of Electrical Installations	Theory Only	1.0	3	0	0	3.0	Electrical Machines
10	BEEE010E	Power Systems Protection and Switchgear	Embedded Theory and Lab	1.0	2	0	2	3.0	Power Systems Analysis
11	BEEE011L	Power Systems Operation and Control	Theory Only	1.0	3	0	0	3.0	Power System Engineering
12	BEEE012L	Restructured Power Systems	Theory Only	1.0	3	0	0	3.0	Power System Engineering
13	BEEE013L	High Voltage Engineering	Theory Only	1.0	3	0	0	3.0	Power System Engineering
14	BEEE014L	Renewable Energy Systems	Theory Only	1.0	3	0	0	3.0	Power Electronics, Power System Engineering
15	BEEE015L	FACTS and HVDC	Theory Only	1.0	3	0	0	3.0	Power Electronics, Power System Engineering
16	BEEE016L	Power Quality	Theory Only	1.0	3	0	0	3.0	Power Systems Analysis
17	BEEE017L	Reliability Engineering	Theory Only	1.0	3	0	0	3.0	Probability and Statistics
18	BEEE018L	Robotics and Control	Theory Only	1.0	3	0	0	3.0	Control Systems
19	BEEE391J	Technical Answers to Real Problems Project	Project	1.0	0	0	0	3.0	
20	BEEE392J	Design Project	Project	1.0	0	0	0	3.0	
21	BEEE393J	Laboratory Project	Project	1.0	0	0	0	3.0	
22	BEEE394J	Product Development Project	Project	1.0	0	0	0	3.0	
23	BEEE395J	Computer Project	Project	1.0	0	0	0	3.0	
24	BEEE396J	Reading Course	Project	1.0	0	0	0	3.0	
25	BEEE397J	Special Project	Project	1.0	0	0	0	3.0	
26	BEEE398J	Simulation Project	Project	1.0	0	0	0	3.0	

Projects and Internship								
sl.no	**Course Code**	**Course Title**	**Course Type**	**Ver**	**L**	**T**	**P**	**Credit**
1	BEEE399J	Summer Industrial Internship	Project	1.0	0	0	0	1.0
2	BEEE497J	Project - I	Project	1.0	0	0	0	3.0
3	BEEE498J	Project - II / Internship	Project	1.0	0	0	0	5.0
4	BEEE499J	One Semester Internship	Project	1.0	0	0	0	14.0

Non-graded Core Requirement								
sl.no	**Course Code**	**Course Title**	**Course Type**	**Ver**	**L**	**T**	**P**	**Credit**
1	BCHY102N	Environmental Sciences	Project	1.0	0	0	0	2.0
2	BEEE101N	Introduction to Engineering	Project	1.0	0	0	0	1.0
3	BEXC100N	Extracurricular Activities	Project	1.0	0	0	0	2.0
4	BHUM101N	Ethics and Values	Online Course	1.0	0	0	0	2.0
5	BSSC101N	Essence of Traditional Knowledge	Project	1.0	0	0	0	2.0
6	BSSC102N	Indian Constitution	Project	1.0	0	0	0	2.0

BCHY101L	Engineering Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To enable students to have fundamental understanding of the basic concepts of different disciplines of chemistry.
2. To provide avenues for learning advanced concepts from school to university
3. To empower students with emerging concepts in applied chemistry to be useful in addressing societal needs
4. To integrate analytical and computational ability with experimental skills to create individuals competent in basic science and its by-product of its application.
5. To offer opportunities to create pathways for self-reliant in terms of knowledge and hiqher learninq

Course Outcomes :

1. Understand the fundamental concepts in organic, inorganic, physical, and analytical chemistry.
2. Analyze the principles of applied chemistry in solving the societal issues.
3. Apply chemical concepts for the advancement of materials.
4. Appreciate the fundamental principles of spectroscopy and the related applications.
5. Design new materials, energy conversion devices and new protective coating techniques.

Module:1 Chemical thermodynamics and kinetics **6 hours**

Laws of thermodynamics - entropy change (selected processes) - spontaneity of a chemical reaction and Gibbs free energy - heat transfer; Kinetics - Concept of activation energy and energy barrier - Arrhenius equation- effect of catalysts (homo and heterogeneous) - Enzyme catalysis (Michaelis-Menten Mechanism).

Module:2 Metal complexes and organometallics **6 hours**

Inorganic complexes - structure, bonding and application; Organometallics - introduction, stability, structure and applications of metal carbonyls, ferrocene and Grignard reagent; Metals in biologq (haemoqlobin, chlorophyll- structure and property).

Module:3 Organic intermediates and reaction transformations **6 hours**

Organic intermediates - stability and structure of carbocations, carbanions and radicals; Aromatics (aromaticity) and heterocycles (3, 4, 5, 6 membered and fused systems); Organic transformations for making useful drugs for specific disease targets (two examples) and dyes (addition, elimination, substitution and cross couplinq reactions).

Module:4 Energy devices **6 hours**

Electrochemical and electrolytic cells - electrode materials with examples (semi-conductors), electrode-electrolyte interface- chemistry of Li ion secondary batteries, supercapacitors; Fuel cells: H2"O_2 and solid oxide fuel cell (SOFC); Solar cells - photovoltaic cell (silicon based), photoelectrochemical cells and dye-sensitized cells.

Module:5 Functional materials **7 hours**

Oxides of AB, AB_2, ABO_3 type (specific examples); Composites - types and properties; Polymers - thermosetting and thermoplastic polymers - synthesis and application (TEFLON, BAKELITE); Conducting polymers- polyacetylene and effect of doping - chemistry of display devices specific to OLEDs; Nano materials - introduction, bulk *vs* nano (quantum dots), top-down and bottom-up approaches for synthesis, and properties of nano Au.

Module:6 Spectroscopic, diffraction and microscopic techniques **5 hours**

Fundamental concepts in spectroscopic and instrumental techniques; Principle and applications of UV-Visible and XRD techniques (numericals); Overview of various techniques such as AAS, IR, **NMR,** SEM and TEM.

Module:7 Industrial applications **7 hours**

Water purification methods - zeolites, ion-exchange resins and reverse osmosis; Fuels and combustion -LCV, HCV, Bomb calorimeter (numericals), anti-knocking agents); Protective coatings for corrosion control: cathodic and anodic protection - PVD technique; Chemical sensors for environmental monitoring - gas sensors; Overview of computational methodologies: energy minimization and conformational analysis.	
Module:8 Contemporary topics	**2 hours**
Guest lectures from Industry and, Research and Development Orqanizations	
Total Lecture hours:	**45 hours**
Textbook	
1. Theodore E. Brown, H Eugene, LeMay Bruce E. Bursten, Catherine Murphy, Patrick Woodward, Matthew E. Stoltzfus, Chemistry: The Central Science, 2017, 14th edition, Pearson Publishers, 2017. UK	
Reference Books	
1. Peter Vollhardt, Neil Schore, Organic Chemistry: Structure and Function, 2018, 8th ed. WH Freeman, London	
2. Atkins' Physical Chemistry: International, 2018, Eleventh edition, Oxford University Press; UK	
3. Colin Banwell, Elaine Mccash, Fundamentals for Molecular Spectroscopy, 4th Edition, McGraw Hill, US	
4. Solid State Chemistry and its Applications, Anthony R. West. 2014, 2nd edition, Wiley, **UK.**	
5. AngA"le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic solar energy: From fundamentals to Applications, 2017, Wiley publishers, **UK.**	
6. Lawrence S. Brown and Thomas Holme, Chemistry for engineering students, 2018, 4th edition - *Open access version*	
Mode of Evaluation: CAT, Written assiqnment, Quiz and FAT	
Recommended by Board of Studies	**28.06.2021**
Approved by Academic Council	No.63 Date 23.09.2021

BCHY101P	**Engineering Chemistry Lab**	IL IT Ip IC
		lo lo I 2 I 1
Pre-requisite	**NIL**	I **Syllabus version**
		I 1.0

Course Objective

To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.

Course Outcome :

At the end of the course the student will be able to

1. Understand the importance and hands-on experience on analysis of metal ions by means of experiments.
2. Get practical experience on synthesis and characterization of the organic molecules and nanomaterials in the laboratory.
3. **Apply** their knowledge in thermodynamic functions, kinetics and molecular qeometries throuqh the experiments.

Indicative Experiments I

1.	Thermodynamics functions from EMF measurements : Zinc - Copper system
2.	Determination of reaction rate, order and molecularity of ethylacetate hydrolysis
3.	Colorimetric estimation of Ni^{2+} using conventional and smart phone digital-imaging methods
4.	Laboratory scale preparation of important drug intermediate - para aminophenol for the synthesis for acetaminophen
5.	Magnesium-sea water activated cell - Effect of salt concentration on voltage Qeneration
6.	Analysis of iron in an alloy sample by potentiometry
7.	Preparation of tin oxide by sol- gel method and its characterization
8.	Size dependent colour variation of Cu_2O nanoparticles by spectrophotometer
9.	Determination of hardness of water sample by complexometric titration before and after ion-exchanQe process
10.	Computational Optimization of molecular Qeometry usinQ AvoQadro software
	Total Laboratory Hours I **30 hours**

Mode of assessment: Mode of assessment: Continuous assessment/ FAT/ Oral examination and others

Recommended by Board of Studies I 2s.06.2021

Approved by Academic Council I No. 63 I Date I 23.09.2021

BCSE101E	Computer Programming: Python	ILITIPIC
		11 lo l 4 l 3
Pre-requisite	NIL	l Syllabus version
		l 1.0

Course Objectives

1. To provide exposure to basic problem-solving techniques using computers.
2. To inculcate the art of logical thinking abilities and propose novel solutions for real world problems throuqh proqramminq lanquaqe constructs.

Course Outcome

1. Classify various algorithmic approaches, categorize the appropriate data representation, and demonstrate various control constructs.
2. Choose appropriate programming paradigms, interpret and handle data using files to propose solution through reusable modules; idealize the importance of modules and packages.

Module:1 l Introduction to Problem Solving l **1 hour**

Problem Solving: Definition and Steps, Problem Analysis Chart, Developing an Algorithm, Flowchart and Pseudocode.

Module:2 l Python Programming Fundamentals l **2 hours**

Introduction to python - Interactive and Script Mode - Indentation - Comments - Variables - Reserved Words - Data Types - Operators and their precedence - Expressions - Built-in Functions - Importing from Packages.

Module:3 l Control Structures l **2 hours**

Decision Making and Branching: if, if-else, nested if, multi-way if-elif statements - Looping: while loop, for loop - else clauses in loops, nested loops - break, continue and pass statements.

Module:4 l Collections l **3 hours**

Lists: Create, Access, Slicing, Negative indices, List methods, List comprehensions - Tuples: Create, Indexing and slicing, Operations on tuples - Dictionary: Create, add, and replace values, Operations on dictionaries - Sets: Creation and operations.

Module:5 l Strings and Regular Expressions l **2 hours**

Strings: Comparison, Formatting, Slicing, Splitting, Stripping - Regular Expressions: Matching,
Search and replace, Patterns.

Module:6 l Functions and Files l **3 hours**

Functions - Parameters and Arguments: Positional arguments, Keyword arguments, Parameters
with default values - Local and Global scope of variables - Functions with Arbitrary arguments - Recursive Functions - Lambda Function. Files: Create, Open, Read, Write, Append and Close - tell and seek methods.

Module:7 l Modules and Packages l **2 hours**

Built-in modules - User-Defined modules - Overview of Numpy and Pandas packages.

l **Total Lecture hours:** l **15 hours**

Text Book(s)

1.	Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Proqramminq, 2nd Edition, No starch Press, 2019

Reference Books

1.	Martic C Brown, Python: The Complete Reference, 4th Edition, McGraw Hill Publishers, 2018.
2.	John V. Guttag, Introduction to computation and programming using python: with applications to understandinq data. 2nd Edition, MIT Press, 2016.

Mode of Evaluation: No separate evaluation for theory component.	
Indicative Experiments	
1.	Problem Analysis Chart, Flowchart and Pseudocode Practices.
2.	Sequential Constructs using Python Operators, Expressions.
3.	Branching (if, if-else, nested if, multi-way if-elif statements) and Looping (for, while, nested looping, break, continue, else in loops).
4.	List, Tuples, Dictionaries & Sets.
5.	Strings, Regular Expressions.
6.	Functions, Lambda, Recursive Functions and Files.
7.	Modules and Packages (NumPy and Pandas)
Total Laboratory Hours	**60 hours**
Text Book(s)	
1.	Mariano Anaya, Clean Code in Python: Develop maintainable and efficient code, 2nd Edition, Packt Publishing Limited, 2021.
Reference Books	
1.	Harsh Bhasin, Python for beginners, 1st Edition, New Age International (P) Ltd., 2019,
	Mode of assessment: Continuous assessments and FAT
Recommended by Board of Studies | 03.07.2021	
Approved by Academic Council | No. 63 | Date | 23.09.2021	

BCSE103E	Computer Programming : Java	L T P C
		1 0 4 3
Pre-requisite	**NIL**	**Syllabus version**
		1.0

Course Objectives:

1. To introduce the core language features of Java and understand the fundamentals of Object -Oriented programming in Java.
2. To develop the ability of usinq Java to solve real world problems.

Course Outcome:

At the end of this course, students should be able to:

1. Understand basic programming constructs; realize the fundamentals of Object Orientated Programming in Java; apply inheritance and interface concepts for enhancing code reusability.
2. Realize the exception handling mechanism; process data within files and use the data structures in the collection framework for solving real world problems.

Module:1	**Java Basics**	**2 hours**

OOP Paradigm - Features of Java Language - JVM - Bytecode - Java program structure - Basic programming constructs - data types - variables - Java naming conventions - operators.

Module:2	**Looping Constructs and Arrays**	**2 hours**

Control and looping constructs - Arrays - one dimensional and multi-dimensional - enhanced for loop - Strings - Wrapper classes.

Module:3	**Classes and Objects**	**2 hours**

Class Fundamentals - Access and non-access specifiers - Declaring objects and assigning object reference variables - array of objects - constructors and destructors - usage of "this" and "static" keywords.

Module:4	**Inheritance and Polymorphism**	**3 hours**

Inheritance - types -- use of "super" - final keyword - Polymorphism - Overloading and Overridinq - abstract class - Interfaces.

Module:5	**Packages and Exception Handling**	**2 hours**

Packages: Creating and Accessing - Sub packages.
Exception Handling - Types of Exception - Control Flow in Exceptions - Use of try, catch, finally, throw, throws in Exception Handling - User defined exceptions.

Module:6	**10 Streams and Files**	**2 hours**

Java **1/0** streams - FileInputStream & FileOutputStream - FileReader & FileWriter- DataInputStream & DataOutputStream - BufferedInputStream & BufferedOutputStream - PrintOutputStream - Serialization and Deserialization.

Module:7	**Collection Framework**	**2 hours**

Generic classes and methods - Collection framework: List and Map.

Total Lecture hours:	**15 hours**

Text Book(s)

1.	Y. Daniel Liang, "Introduction to Java programming" - comprehensive version-11tn Edition, Pearson publisher, 2017.

Reference Books

1.	Herbert Schildt , The Complete Reference -Java, Tata McGraw-Hill publisher, 10th Edition, 2017.
2	Cay Horstmann,"Biq Java", 4th edition, John Wiley & Sons publisher, 5th edition, 2015
3	E.Balagurusamy, "Programming with Java", Tata McGraw-Hill publishers, 6th edition, 2019

Mode of Evaluation: No separate evaluation for theory component.	
Indicative Experiments	
1.	Programs using sequential and branching structures.
2.	Experiment the use of loopinq, arrays and strinqs.
3.	Demonstrate basic Object-Oriented proqramminq elements.
4.	Experiment the use of inheritance, polymorphism and abstract classes.
5.	Desiqninq packaqes and demonstrate exception handlinq.
6.	Demonstrate the use of 10 streams, file handlinq and serialization.
7.	Proqram to discover application of collections.
Total Laboratory Hours | 60 hours	
Text Book(s)	
1.	Marc Loy, Patrick Niemeyer and Daniel Leuck, Learning Java, O'Reilly Media, Inc., 5th Edition, 2020.
Reference Books	
1.	Dhruti Shah, 100+ Solutions in Java: A Hands-On Introduction to Programming in Java, BPB Publications, 1st Edition, 2020.
Mode of assessment: Continuous assessments and FAT	
Recommended by Board of Studies | 03.07.2021	
Approved by Academic Council | No. 63 | Date | 23.09.2021	

BECE101L	Basic Electronics	IL IT Ip IC
		12 IO IO I 2
Pre-requisite	Nil	I Syllabus version
		I 1.0

Course Objectives

1. To introduce the students to the basic concepts of electronic components, sources, measurements. and instrumentation.
2. To apply the inculcated knowledge for developing simple circuits using various electronic components and devices
3. To familiarize the students with the basic concepts of number systems and digital logic.
4. To analyse the concepts associated with multiple sensors and their sensing mechanisms.

Course Outcome

Students will be able to

1. Understand the basic electronic components, sources, and measuring equipment
2. Comprehend the characteristics of diodes, transistors and their applications
3. Design and analyse the amplifiers and oscillators
4. Design and implement simple digital circuits
5. Analyse the performance metrics of the measurement systems.
6. Comprehend the basic concept of various sensors and their sensinQ mechanisms.

Module:1 I Electronic Components, Sources, and Measuring Equipment I 3 hours

Evolution of Electronics - Impact of Electronics in Industry and Society - Familiarization of Resistors, Capacitors, Inductors - Colour Coding - types and specifications, - Electro-mechanical components - Relay and Contactors - Regulated Power supply, Function Generator - Multimeter - CRO

Module:2 I Junction Diodes I 4 hours

Intrinsic and extrinsic semiconductors - doping - PN Junctions, Formation of Junction, Physical operation of diode, Barrier Potential, I - V Characteristics, Rectifiers, Zener diode - 1-V Characteristics, Zener diode as Voltage regulator.

Module:3 I Transistors I 5 hours

Bipolar Junction Transistor (BJT) - Device structure and physical operation, Concept of CB, CE and CC Configuration, Transistor as a Switch, - Metal-Oxide Field Effect Transistor (MOSFET) - Device Structure, mode of operation and Characteristics, MOSFET configurations (CS, CD, CG).

Module:4 I Amplifiers and Oscillators I 4 hours

BJT as an amplifier (CE configuration), MOSFET as an amplifier (CS configuration), Feedback concept, Oscillators - Barkhaunsen's criteria for sustained oscillation, RC Phase Shift Oscillator, LC Oscillator.

Module:5 I Digital Logics I 4 hours

Number systems, conversion of bases, Boolean algebra, Logic Gates, Concept of universal gate, Simplification and implementation of Boolean functions.

Module:6 I Principles of Measurement and Analysis I 3 hours

Units and standards, Errors, Functional Elements of a Measurement System and Instruments, Applications and Classification of Instruments, Types of measured Quantities, Measures of Dispersion, Sample deviation and sample mean, Calibration and standard.

Module:7 I Sensors and Transducers I 5 hours

Sensor fundamentals and characteristics - General concepts and terminology of measurement systems, Sensors and transducers - Classification of sensors, Static and dynamic characteristics. Principle of Resistive Sensors, Capacitive Sensors, Inductive Sensors, Maqnetic sensors, Optical sensor, Self-qeneratinq Sensors

Module:8 I Contemporary issues I 2 hours

Guest lectures from Industry and, Research and Development Orqanisations

Total Lecture hours: I 30 hours

Text Book(s)	
1.	A. P. Malvina, D. J. Bates, Electronic Principles, 2017, 7/e, Tata McGraw-Hill.
2	Albert D. Helfrick and William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 2016, First Edition, Pearson Education, Naida, India.
Reference Books	
1.	David A Bell, Electronic Devices and Circuits, Oxford Press, 5$^{1}_{n}$ Edition, 2008
2	Robert L. Bolysted and Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice Hall of India, 11th Edition, 2017
3	D. Patranabis - Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
4	A.K. Sawhney, Puneet Sawhney, A Course In Electrical and Electronic Measurements, and Instrumentation, Dhanpat Rai & Co., 2015
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Diaital Assianments) & FAT	
Recommended by Board of Studies I os.01.2021	
Aooroved by Academic Council I No. 63 I Date I 23.09.2021	

BECE101P	Basic Electro ics Lab	ILTTPIC
		Io Io I 2 11
Pre-requisite	**Nil**	**Syllabus version**
		1.0

Course Objectives

1. To learn the various characteristics of diodes and transistors
2. To understand the concept of digital logic functions and verify the truth tables
3. To learn the performance metrics of measurement systems and characteristics of various sensors

Course Outcome

Students will be able to
1. Analyse the various characteristics and applications of diodes and transistors
2. Design logic circuits using logic gates and verify their truth tables
3. Measure the physical parameters using different transducers

Indicative Experiments

1	Identify, mark the terminal and find the value of a particular component from the given group of electronic components, Study of electronic measurement devices (Multimeter, DSO, function generator)
2	V-I Characteristics of PN Junction diodes and Zener diodes
3	Half Wave and Full Wave Rectifier circuits
4	Zener Diode as a voltage regulator
5	Characteristics of BJT in Common Emitter Configuration
6	Characteristics of MOSFET in Common Source Configuration
7	Frequency response of BJT single stage amplifier
8	Study of the signal generation using RC Phase Shift Oscillator
9	Study of logic gates and implementation of Boolean Functions
10	Strain gauge sensors for measurement of normal strain.
11	Displacement measurement using LVDT and LOR.
12	Temperature measurement using RTD, Thermistor and Thermocouple.

Total Laboratory Hours I 30 hours

Text Book(s)

1.	A. P. Malvina, D. J. Bates, Electronic Principles, 2017, 7/e, Tata McGraw-Hill.
2	Albert D. Helfrick and William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 2016, First Edition, Pearson Education, Naida, India.

Reference Books

1.	Robert L. Bolysted and Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice Hall of India, 11th Edition, 2017
2	D. Patranabis - Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003

Mode of assessment: Continuous assessment/ FAT/ Oral examination and others

Recommended by Board of Studies I os.07.2021

Approved by Academic Council I No. 63 I Date I 23.09.2021

BEEE101L	Basic Electrical Engineering	ILITIPIC
		I 2 lo lo I 2
Pre-requisite	**NIL**	I **Syllabus version**
		I 1.0

Course Objectives

1. Provide insights into relevant concepts and principles in electrical engineering
2. Facilitate understand and comprehend laws, rules and theorems to compute parameters of electric circuits
3. Enable comprehend and analyze the concepts of electrical machines and measuring instruments

Course Outcome

On completion of this course, the students will be able to

1. Evaluate DC and AC circuit parameters using various laws and theorems
2. Analyze the parameters of magnetically coupled circuits and compare various types of electrical machines
3. Comprehend the measurement techniques of electrical parameters
4. Understand the concept of electric supply system and comprehend essential electrical safety requirements

Module:1 I DC Circuits I **6 hours**

Basic circuit elements and sources; Ohms law, Kirchhoff's laws; Series and parallel connection of circuit elements; Source transformation; Node voltage analysis; Mesh current analysis; Maximum power transfer theorem

Module:2 I AC Circuits I **6 hours**

Alternating voltages and currents, RMS, average, form factor, peak factor; Single phase RL, RC, RLC series and parallel circuits; Power and power factor; Balanced three phase systems

Module:3 I Magnetic Circuits I **4 hours**

Electromagnetic Induction: Self and mutual; Magnetically coupled circuits; Series and parallel magnetic circuits; Dot convention

Module:4 I Electrical Machines I **5 hours**

Principle of operation, construction and applications of DC machines, transformers, induction motors, synchronous generators, stepper motor, Brushless DC (BLOC) motor

Module:5 I Electrical Measurements I **4 hours**

Principle, Construction and operation of moving coil and moving iron instruments; Power and energy measurement in single phase and three phase systems

Module: 6 I Electrical Supply Systems & Safety I **3 hours**

Concepts of electrical power generation, transmission and distribution systems; Wiring; Electrical safety; Earthing; Protective devices

Module: 7 I Contemporary Issues I **2 hours**

Guest lectures from Industry and, Research and Development Organizations

I **Total Lecture hours:** I **30 hours**

Text Book(s)

1. Allan R. Hambley, Electrical Engineering: Principles & Applications, 2019, tn edition, Pearson Education

Reference Books

1. DP Kothari & I J Nagrath, Basic Electric Engineering, 2019, 4[1]nedition, McGraw Hill Education
2. John Bird, Electrical Circuit Theory and Technology, 2013, 5th edition, Routledge Publications
3. S. Salivahnan, R Rengaraj, G R Venkatakrishnan, Basic Electrical, Electronics and Measurement Engineering, 2018, McGraw Hill Education
4. E.W Golding, F.C Widdis, Electrical Measurements and Measuring Instruments,

I 2011, Reem Publications
5. I V K Mehta and Rohit Mehta, Principles of Power System, 2005, S. Chand
Mode of Evaluation: CAT, Written Assignment, Quiz, FAT
Recommended by Board of Studies I 03.07.2021
Approved by Academic Council I No. 63 I Date I 23.09.2021

BEEE101P	Basic I ectrical Engineering Lab	ILITIPIC
		Io Io I 2 11
Pre-requisite	**NIL**	I **Syllabus version**
		I 1.0

Course Objectives

1. Understanding the concepts of electrical engineering for development and implementation of electrical systems
2. Impart knowledge and skill in wiring and its standards
3. Facilitate comprehend and identify appropriate measuring devices for an electric circuit

Course Outcome

On completion of this course, the students will be able to

1. Understand, analyze and validate the electric circuit parameters
2. Design and develop electrical systems for domestic and commercial applications
3. Acquire skills for interpretation of measurement during experimentation
4. Attain skills to use modern engineering tools for electrical system layout planning

Indicative Experiments

1	Verification of Kirchhoff's voltaqe law
2	Verification of Kirchhoff's current law
3	Verification of maximum power transfer theorem
4	Sinusoidal steady state response of RLC circuits
5	Wirinq circuit for a sinqle lamp and a fan with requlator
6	Wirinq circuit for Godown with two-way switch
7	Load test on single phase transformer/DC motor
8	Measurement of power in a single phase AC Load
9	Measurement of power and energy consumed by a given three phase AC load
10	Study of earthing and measurement of earth pit resistance
11	Cost estimation of residential electrical wiring
12	Electrical layout for a residential/commercial/industrial application usinq CAD software

Total Laboratory Hours I 30 hours

Text Book(s)

1	Allan R. Hambley, Electrical Engineering: Principles & Applications, 2019, ?1n edition, Pearson Education

Mode of assessment: CAT, FAT, Oral examination

Recommended by Board of Studies I 03.07.2021

Approved by Academic Council I No. 63 I Date I 23.09.2021

BENG101L	Technical English Communication	ILITIPIC
		2 lo lo 2
Pre-requisite	NIL	Syllabus version
		1.0

Course Objectives:

1. To develop LSRW skills for effective communication in professional situations
2. To enhance knowledge of grammar and vocabulary for meaningful communication
3. To understand information from diverse texts for effective technical communication

Course Outcomes:

1. Use grammar and vocabulary appropriately while writing and speaking
2. Apply the concepts of communication skills in formal and informal situations
3. Demonstrate effective reading and listening skills to synthesize and draw intelligent inferences
4. Write clearly and significantly in academic and general contexts

Module:1 Introduction to Communication	**4 hours**
Nature and Process - Types of communication: Intra-personal, Interpersonal, Group-verbal and non-verbal communication / Cross-cultural Communication - Communication Barriers and Essentials of good communication - Principles of Effective Communications	
Module:2 Grammatical Aspects	**4 hours**
Sentence Pattern - Modal Verbs - Concord (SVA) - Conditionals - Error detection	
Module:3 Written Correspondence	**4 hours**
Job Application Letters - Resume Writing - Statement of Purpose	
Module:4 Business Correspondence	**4 hours**
Business Letters: Calling for Quotation, Complaint & Sales Letter - Memo - Minutes of Meeting - Describing products and processes	
Module:5 Professional Writing	**4 hours**
Paraphrasing & Summarizing - Executive Summary - Structure and Types of Proposal - Recommendations	
Module:6 Team Building & Leadership Skills	**4 hours**
Principles of Leadership - Team Leadership Model - Negotiation Skills - Conflict Manaqement	
Module:7 Research Writing	**4 hours**
Interpreting and Analysing a research article - Approaches to Review Paper Writing - Structure of a research article - Referencinq	
Module:8 Guest Lecture from Industry and R&D organizations	**2 hours**
Contemporary Issues	
Total Lecture hours:	**30 hours**

Text Book(s)

1. Raman, Meenakshi & Sangeeta Sharma. (2015). *Technical Communication: Principles and Practice,* (3rd Edition). India: Oxford University Press.

Reference Books

1. Taylor, Shirley & Chandra .V. (2010). *Communication for Business A Practical Approach* 4th Edition. India: Pearson Longman.
2. Kumar, Sanjay & Pushpalatha. (2018). *English Language and Communication Skills for Enqineers.* India: Oxford University Press.
3. Koneru Aruna. *(2020). English Language Skills for Engineers.* India: McGraw Hill Education.
4. Rizvi, M. Ashraf. (2018). *Effective Technical Communication* 2nd Edition. Chennai: McGraw Hill Education.
5. Mishra, Sunitha & Muralikrishna,C. (2014). *Communication Skills for Engineers.* India: Pearson Education.

6. Watkins, P. (2018). *Teaching and Developing Reading Skills: Cambridge Handbooks for Lan ua e teachers.* India: Cambrid e Universit Press.			
Mode of Evaluation: CAT/ Assi nment /Quiz/ FAT/ Group Discussion			
Recommended b Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BENG101P	**Technical English Communication Lab**	ILTTPIC Io Io I 2 11
Pre-requisite	**NIL**	**Syllabus version**
		1.0

Course Objectives:

1. To use appropriate grammatical structures in professional communication
2. To improve English communication skills for better employability
3.To enhance meaninqful communication skills in writinq and public speakinq

Course Outcomes:

1. Demonstrate professional rhetoric and articulate ideas effectively
2. Interpret material on technology and deliver eloquent presentations
3. Apply receptive and productive skills in real life situations and develop workplace communication

Indicative Experiments

1.	**Grammar** & **Vocabulary** Error Detection **Activity:** -Worksheets
2.	**Listening to Narratives** Interviews of eminent personalities & Ted Talks **Activity:** Listening Comprehension / Summarising
3.	**Video Resume** SWOT Analysis & digital resume techniques **Activity:** Preparing a digital resume for mock interview
4.	**Product** & **Process Description** Describing and Sequencing **Activity:** Demonstration of product and process
5.	**Mock Meetings** Types of meetings and meeting etiquette **Activity: Conduct of meetings and drafting minutes of the meeting**
6.	**Reading research article** Scientific and Technical articles **Activity:** Writing Literature review
7.	**Analytical Reading** Case Studies on Communication, Team Building and Leadership **Activity:** Group Discussion
8.	**Presentations** Preparing Conference/Seminar paper **Activity:** Individual/ Group presentations
9.	**Intensive Listening** Scientific documentaries **Activity:** Note taking and Summarising
10.	**Interview Skills** Interview questions and techniques **Activity:** Mock Interviews

Total Laboratory Hours I 30 hours

Mode of Assessment: Continuous Assessment/ FAT/ Written Assignments/ Quiz/ Oral Presentation and Group Activity.

Recommended by Board of Studies	2s.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BENG102P	Technical Report Writing	LTPIC
		0 0 2 11
Pre-requisite	Technical English Communication	**Syllabus version**
		1.0

Course Objectives:

1. To augment specific writing skills for preparing technical reports
2. To think critically, evaluate, analyse general and complex technical information
3. To acquire proficiency in writing and presenting reports

Course Outcomes:

1. Write error free sentences using appropriate grammar, vocabulary and style
2. Synthesize information and concepts in preparing reports
3. Demonstrate the ability to write and present reports on diverse topics

Indicative Experiments

1.	**Advanced Grammar, Vocabulary and Editing** Usage of Tenses - Adjectives and Adverbs - Jargon vs Technical Vocabulary – Abbreviations - Mechanics of Editing: Punctuation and Proof Reading **Activity:** Worksheets
2.	**Research and Analyses** Synchronise Technical Details from Newspapers - Magazines - Articles and e-content **Activity:** Writing introduction and literature review
3.	**Systematisation of Information** Techniques to Converge Objective-Oriented data in Diverse Technical Reports **Activity:** Preparing Questionnaire
4.	**Data Visualisation** Interpreting Data - Graphs - Tables– Charts - Imagery - Infographics **Activity:** Transcoding
5.	**Introduction to Reports** Meaning - Definition - Purpose - Characteristics and Types of Reports **Activity:** Worksheets on Types of reports
6.	**Structure of Reports** Title– Preface– Acknowledgement - AbstracUSummary- Introduction - Materials and Methods– Results– Discussion - Conclusion - Suggestions/Recommendations **Activity:** Identifying the structure of report
7.	**Report Writing** Data Collection - Draft an Outline and Organize Information **Activity:** Drafting reports
8.	**Supplementary Texts** Appendix– Index– Glossary– References– Bibliography - Notes **Activity:** Organizing supplementary texts
9.	**Review of Final Reports** Structure– Content– Style - Layout and Referencing **Activity:** Examining clarity and coherence in final reports
10.	**Presentation** Presenting Technical Reports **Activity:** Planning, creating and digital presentation of reports
	Total Laboratory Hours 30 hours

Mode of assessment: Continuous Assessment/ FAT/ Assignments/ Quiz/ Presentations/ Oral examination

Recommended by Board of Studies	28.06.2021		
Aooroved by Academic Council	No. 63	Date	23.09.2021

BMAT101L	Calculus	ILTTIPIC
		3 0 0 3
Pre-requisite	Nil	Syllabus version
		1.0

Course Objectives

1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.
3. Enhance to use technology to model the physical situations into mathematical problems, experiment, interpret results, and verify conclusions.

Course Outcomes

At the end of the course the student should be able to:
1. Apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions
2. Evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints
3. Evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.
4. Use special functions to evaluate various types of integrals.
5. Understand gradient, directional derivatives, divergence, curl, Green's, Stokes and Gauss Divergence theorems.

Module:1 ı Single Variable Calculus	**8 hours**

Differentiation- Extrema on an Interval Rolle's Theorem and the Mean value theorem-Increasing and decreasing functions.-First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution.

Module:2 ı Multivariable Calculus	**5 hours**

Functions of two variables-limits and continuity-partial derivatives -total differential-Jacobian and its properties.

Module:3 ı Application of Multivariable Calculus	**5 hours**

Taylor's expansion for two variables-maxima and minima-constrained maxima and minima-Laqranqe's multiplier method.

Module:4 ı Multiple integrals	**8 hours**

Evaluation of double integrals-change of order of integration-change of variables between Cartesian and polar co-ordinates - evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates.

Module:5 ı Special Functions	**6 hours**

Beta and Gamma functions-interrelation between beta and gamma functions-evaluation of multiple integrals using gamma and beta functions. Dirichlet's integral -Error functions complementary error functions.

Module:6 ı Vector Differentiation	**5 hours**

Scalar and vector valued functions - gradient, tangent plane-directional derivative-divergence and curl-scalar and vector potentials. Statement of vector identities-simple problems.

Module:7 ı Vector Integration	**6 hours**

Line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector inteqrals usinq them.

Module:8 ı Contemporary Topics	**2 hours**

Guest lectures from Industry and, Research and Development Orqanizations

Total Lecture hours:	**45 hours**

Text Book

1. George B.Thomas, D.Weir and J. Hass, Thomas Calculus, 2014, 13th edition, Pearson

Reference Books	
1.	Erwin KreyszigQ, Advanced EnQineerinQ Mathematics, 2015, 10th Edition, Wiley India
2.	B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers
3.	John Bird, Higher Engineering Mathematics, 2017, 6th Edition, Elsevier Limited.
4.	James Stewart, Calculus: Early Transcendental, 2017, 8th edition, Cengage Learning.
5.	K.A.Stroud and Dexter J. Booth, Engineering Mathematics, 2013, 7th Edition, Palgrave Macmillan.
Mode of Evaluation: CAT, AssiQnment, Quiz and FAT	
Recommended by Board of Studies | 24.06.2021	
Approved by Academic Council | No. 63 | Date | 23.09.2021	

BMAT101P	**Calculus Lab**	ILTTPIC lo lo l 2 11
Pre-requisite	**NIL**	**Syllabus version**
		1.0

Course Objectives

1. To familiarize with the basic syntax, semantics and library functions of MATLAB which serves as a tool not only in calculus but also many courses in engineering and sciences
2. To visualize mathematical functions and its related properties.
3. To evaluate single and multiple integrals and understand it graphically.

Course Outcomes

At the end of the course the student should be able to:

1. Demonstrate MATLAB code for challenging problems in engineering
2. Using plots/displays, interpret and illustrate elementary mathematical functions and procedures.

Indicative Experiments

1.	Introduction to MATLAB through matrices and general Syntax
2.	Plotting and visualizing curves and surfaces in MATLAB - Symbolic computations using MATLAB
3.	Evaluating Extremum of a single variable function
4.	Understanding integration as Area under the curve
5.	Evaluation of Volume by Integrals (Solids of Revolution)
6.	Evaluating maxima and minima of functions of two variables
7.	Applying Lagrange multiplier optimization method
8.	Evaluating Volume under surfaces
9.	Evaluating triple integrals
10.	Evaluating gradient, curl and divergence
11.	Evaluating line integrals in vectors
12.	Applying Green's theorem to real world problems

Total Laboratory Hours **30 hours**

Text Book

1.	Brian H. Hahn, Daniel T. Valentine, Essential MATLAB for Engineers and Scientists, Academic Press, 7th edition, 2019.

Reference Books

1.	Amos Gilat, MATLAB: An Introduction with Applications, Wiley, 6/e, 2016.
2	Maritn Brokate, Pammy Manchanda, Abul Hasan Siddiqi, Calculus for Scientists and Engineers, Springer, 2019

Mode of assessment: DA and FAT

Recommended by Board of Studies | 24.06.2021

Aooroved by Academic Council | No. 63 | Date | 23.09.2021

BMAT102L	Differential Equations and Transforms	IL IT IP IC
		3 11 0 14
Pre-requisite	**BMAT101L, BMAT101P**	**Syllabus version**
		1.0

Course Objectives

1. To impart the knowledge of Laplace transform, an important transform techniques for Engineers which requires knowledge of integration.
2. Presenting the elementary notions of Fourier series, this is vital in practical harmonic analysis.
3. Enriching the skills in solving initial and boundary value problems.
4. Impart the knowledge and application of difference equations and the Z-transform in discrete systems that are inherent in natural and physical processes.

Course Outcomes

At the end of the course the student should be able to:

1. Find solution for second and higher order differential equations, formation and solving partial differential equations.
2. Understand basic concepts of Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution.
3. Employ the tools of Fourier series and Fourier transforms.
4. Know the techniques of solving differential equations and partial differential equations.
5. Know the Z-transform and its application in population dynamics and digital signal processing.

Module:1 Ordinary Differential Equations (ODE)	**6 hours**

Second order non- homogenous differential equations with constant coefficients- Differential equations with variable coefficients- method of undetermined coefficients-method of Variation of parameters-Solving Damped forced oscillations and LCR circuit theory problems.

Module:2 Partial Differential Eauations (PDE)	**5 hours**

Formation of partial differential equations - Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation-Method of separation of variables

Module:3 Laplace Transform	**7 hours**

Definition- Properties of Laplace transform-Laplace transform of standard functions - Laplace transform of periodic functions-Unit step function-Impulse function. Inverse Laplace transform-Partial fractions method and by Convolution theorem..

Module:4 Solution to ODE and PDE by Laplace transform	**7 hours**

Solution of ODE's - Non-homogeneous terms involving Heaviside function, Impulse function - Solving Non-homogeneous system using Laplace transform - solution to First order PDE by Laplace transform.

Module:5 Fourier Series	**6 hours**

Fourier series - Euler's formulae- Dirichlet's conditions - Change of interval - Half range series - RMS value - Parseval's identity.

Module:6 Fourier Transform	**6 hours**

Complex Fourier transform - properties - Relation between Fourier and Laplace Transforms- Fourier sine and cosine transforms - Parseval's identity- Convolution Theorem and simple applications to solve PDE.

Module:7 Z-Transform	**6 hours**

Definition of Z-transform and Inverse Z-transform - Standard functions - Partial fractions and

convolution method. Difference equation - first and second order difference equations with constant coefficients - solution of simple difference equations usino Z-transform.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours: **Total Tutorial hours:**	**45 hours** **15 hours**

Text Book(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, John Wiley India.
2. B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers.

Reference Books

1. Michael D. Greenberg, Advanced Engineering Mathematics, 2006, 2nd Edition, Pearson Education, Indian edition.
2. A First Course in Differential Equations with Modelling Applications, Dennis Zill, 2018, 11th Edition, Cengage Publishers.

Mode of Evaluation: CAT, written assignment, Quiz, FAT

Recommended by Board of Studies	24-06-2021
Approved by Academic Council	No. 64 Date 16-12-2021

BMAT201L	Complex Variables and Linear Algebra	IL IT IP IC
		3 1 0 4
Pre-requisite	**BMAT102L**	**Syllabus version**
		1.0

Course Objectives

1. To present comprehensive, compact, and integrated treatment of one of the most important branches of applied mathematics namely Complex variables to the engineers and the scientists.
2. To present comprehensive, compact, and integrated treatment of another most important branches of applied mathematics namely Linear Algebra to the engineers and the scientists.
3. To provide students with a framework of the concepts that will help them to analyse deeply about many complex problems.

Course Outcomes

At the end of the course the student should be able to

1. Construct analytic functions and find complex potential of fluid flow and electric fields.
2. Find the image of straight lines by elementary transformations and to express analytic functions in power series.
3. Evaluate real integrals using techniques of contour integration.
4. Use the power of inner product and norm for analysis.
5. Use matrices and transformations for solving engineering problems.

Module:1 Analytic Functions	**7hours**
Complex variable - Analytic functions and Cauchy - Riemann equations; Laplace equation and Harmonic functions; Construction of Harmonic conjugate and analytic functions; Applications of analytic functions to fluid-flow and electric field problems.	
Module:2 Conformal and Bilinear transformations	**7 hours**
Conformal mapping - Elementary transformations; Translation, Magnification, Rotation, Inversion; Exponential and Square transformations ($w = e^z$, z^2); Bilinear transformation; Cross-ratio-Images of the regions bounded by straight lines under the above transformations;	
Module:3 Complex Integration	**7 hours**
Functions given by Power Series - Taylor and Laurent series-Singularities - Poles - Residues; Integration of a complex function along a contour; Statements of Cauchy-Goursat theorem- Cauchy's integral formula-Cauchy's residue theorem-Evaluation of real integrals-Indented contour integral.	
Module:4 Vector Spaces	**6 hours**
Vector space - subspace; linear combination - span - linearly dependent - Independent - bases; Dimensions; Finite dimensional vector space. Row and column spaces; Rank and nullity.	
Module:5 Linear Transformations	**6 hours**
Linear transformations - Basic properties; Invertible linear transformation; Matrices of linear transformations; Vector space of linear transformations; Change of bases; Similarity.	
Module:6 Inner Product Spaces	**5 hours**
Dot products and inner products; Lengths and angles of vectors; Matrix representations of inner products; Gram - Schmidt - Orthogonalization.	
Module:7 Matrices and System of Equations	**5 hours**
Eigenvalues and Eigen vectors; Properties of Eigenvalues and Eigen vectors; Cayley-Hamilton theorem; System of linear equations; Gaussian elimination and Gauss Jordan methods.	
Module:8 Contemporary issues:	**2 hours**

	Total Lecture hours:	**45 hours**
	Total Tutorial hours :	**15 hours**

Text Book(s)

1. G. Dennis Zill, Patrick D. Shanahan, A first course in complex analysis with applications, 2013, 3rd Edition, Jones and Bartlett Publishers Series in Mathematics.
2. Jin Ho Kwak, Sungpyo Hong, Linear Algebra, 2004, Second edition, Springer.

Reference Books

1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, $10^{1}{}_{n}$ Edition, John Wiley & Sons (Wiley student Edition).
2. Michael, D. Greenberg, Advanced Engineering Mathematics, 2006, 2^{nd} Edition, Pearson Education.
3. Bernard Kolman, David, R. Hill, Introductory Linear Algebra - An applied first course, 2011, 9th Edition Pearson Education.
4. Gilbert Strang, Introduction to Linear Algebra, 2015, 5th Edition, Cengage Learning
5. B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers.

Mode of Evaluation: Digital Assignments(Solutions by using soft skill), Quiz, Continuous Assessments, Final Assessment Test.

Recommended by Board of Studies	24-06-2021
Approved by Academic Council	No. 64 Date 16-12-2021

BMAT202L	Probability and Statistics	IL	IT	IP	IC
		3	0	0	3
Pre-requisite	**BMAT101L, BMAT101P**	**Syllabus version**			
		1.0			

Course Objectives :

1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations.
2. To analyze distributions and relationship of real-time data.
3. To apply estimation and testing methods to make inference and modelling techniques for decision making.

Course Outcome :

At the end of the course the student should be able to:

1. Compute and interpret descriptive statistics using numerical and graphical techniques.
2. Understand the basic concepts of random variables and find an appropriate distribution for analyzing data specific to an experiment.
3. Apply statistical methods like correlation, regression analysis in analyzing, interpreting experimental data.
4. Make appropriate decisions using statistical inference that is the central to experimental research.
5. Use statistical methodology and tools in reliability engineering problems.

Module:1 Introduction to Statistics — **6 hours**

Statistics and data analysis; Measures of central tendency; Measure of Dispersion, Moments-Skewness-Kurtosis (Concepts only).

Module:2 Random variables — **8 hours**

Random variables- Probability mass function, distribution and density functions-Joint probability distribution and Joint density functions; Marginal, Conditional distribution and Density functions- Mathematical expectation and its properties- Covariance, Moment generating function.

Module:3 Correlation and Regression — **4 hours**

Correlation and Regression - Rank Correlation; Partial and Multiple correlation; Multiple regression.

Module:4 Probability Distributions — **7 hours**

Binomial distribution; Poisson distributions; Normal distribution; Gamma distribution; Exponential distribution; Weibull distribution.

Module:5 Hypothesis Testing-I — **4 hours**

Testing of hypothesis -Types of errors - Critical region, Procedure for testing of hypothesis- Large sample tests- Z test for Single Proportion- Difference of Proportion- Mean and difference of means.

Module:6 Hypothesis Testing-II — **9 hours**

Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance - One way-Two way-Three way classifications - CRD-RBD- LSD.

Module:7 Reliability — **5 hours**

Basic concepts- Hazard function-Reliabilities of series and parallel systems- System

Reliability - Maintainability-Preventive and repair maintenance- Availability.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book:

1. R. E. Walpole, R. H. Myers, S. L. Mayers, K. Ye, Probability and Statistics for engineers and scientists, 2012, 9th Edition, Pearson Education.

Reference Books

1. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, 2016, 6th Edition, John Wiley & Sons.
2. E. Balagurusamy, Reliability Engineering, 2017, Tata McGraw Hill, Tenth reprint.
3. J. L. Devore, Probability and Statistics, 2012, 8th Edition, Brooks/Cole, Cengage Learning.
4. R. A. Johnson, Miller Freund's, Probability and Statistics for Engineers, 2011, 8th edition, Prentice Hall India.
5. Bilal M. Ayyub, Richard H. Mccuen, Probability, Statistics and Reliability for Engineers and Scientists, 2011, 3rd edition, CRC press.

Mode of Evaluation: Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test.

Recommended by Board of Studies	24-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BMAT202P	Probability and Statistics Lab	L IT IP IC
		0 IO I 2 II
Pre-requisite	BMAT101L, BMAT101P	Syllabus version
		1.0

Course Objectives:

1. To enable the students for having experimental knowledge of basic concepts of statistics using R programming.
2. To study the relationship of real-time data and decision making through testing methods using R.
3. To make students capable to do experimental research using statistics in various engineering problems.

Course Outcomes:

At the end of the course the student should be able to:

1. Demonstrate R programming for statistical data.
2. Carry out appropriate analysis of statistical methods through experimental techniques using R.

Indicative Experiments

1.	Introduction: Understanding Data types; importing/exporting data	Total Laboratory hours: 30
2.	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations	
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination	
4.	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficients of determination	
5.	Fitting the probability distributions: Binomial distribution	
6.	Normal distribution, Poisson distribution	
7.	Testing of hypothesis for one sample mean and proportion from real time problems	
8.	Testing of hypothesis for two sample means and proportion from real time problems	
9.	Applying the t-test for independent and dependent samples	
10.	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	
11.	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design, Latin square Design	

Text Book

1. Statistical analysis with R by Joseph Schmuller, John wiley and sons Inc., New Jersey 2017.

Reference Books:

1. The Book of R: A First course in Programming and Statistics, by Tilman M Davies, William Pollock, 2016.
2. R for Data Science, by Hadley Wickham and Garrett Grolemund, O' Reilly Media Inc., 2017.

Mode of assessment: Continuous assessment, FAT/ Oral examination and others

Recommended by Board of Studies | 24-06-2021

Approved by Academic Council | No. 64 | Date | 16-12-2021

Course Code	Course Title	L	T	P	C
BPHY101L	Engineering Physics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To explain the dual nature of radiation and matter.
2. To apply Schrödinger's equation to solve finite and infinite potential problems and apply quantum ideas at the nanoscale.
3. To understand the Maxwell's equations for electromagnetic waves and apply the concepts to semiconductors for engineering applications.

Course Outcome

At the end of the course the student will be able to

1. Comprehend the phenomenon of waves and electromagnetic waves.
2. Understand the principles of quantum mechanics.
3. Apply quantum mechanical ideas to subatomic domain.
4. Appreciate the fundamental principles of a laser and its types.
5. Design a typical optical fiber communication system using optoelectronic devices.

Module:1	**Introduction to waves**	**7 hours**
Waves on a string - Wave equation on a string (derivation) - Harmonic waves- reflection and transmission of waves at a boundary (Qualitative) - Standing waves and their eigenfrequencies.		
Module:2	**Electromagnetic waves**	**7 hours**
Physics of divergence - gradient and curl - Qualitative understanding of surface and volume integral - Maxwell Equations (Qualitative) - Displacement current - Electromagnetic wave equation in free space - Plane electromagnetic waves in free space - Hertz's experiment.		
Module:3	**Elements of quantum mechanics**	**6 hours**
Need for Quantum Mechanics: Idea of Quantization (Planck and Einstein) - Compton effect (Qualitative) – de Broglie hypothesis - - Davisson-Germer experiment - Wave function and probability interpretation - Heisenberg uncertainty principle - Schrödinger wave equation (time dependent and time independent).		
Module:4	**Applications of quantum mechanics**	**5 hours**
Eigenvalues and eigenfunction of particle confined in one dimensional box - Basics of nanophysics - Quantum confinement and nanostructures - Tunnel effect (qualitative) and scanning tunneling microscope.		
Module:5	**Lasers**	**6 hours**
Laser characteristics - spatial and temporal coherence - Einstein coefficients and their significance - Population inversion - two, three and four level systems - Pumping schemes - threshold gain coefficient - Components of a laser - He-Ne, Nd:YAG and CO2 lasers and their engineering applications.		
Module:6	**Propagation of EM waves in optical fibers**	**6 hours**
Introduction to optical fiber communication system - light propagation through fibers - Acceptance angle - Numerical aperture - V-parameter - Types of fibers – Attenuation - Dispersion-intermodal and intramodal. Application of fiber in medicine - Endoscopy.		
Module:7	**Optoelectronic devices**	**6 hours**
Introduction to semiconductors - direct and indirect bandgap – Sources: LED and laser diode, Photodetectors: PN and PIN.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Textbook(s)	
1.	H. D. Young and R. A. Freedman, University Physics with Modern Physics, 2020, 15th Edition, Pearson, USA.
2.	D. K. Mynbaev and Lowell L. Scheiner, Fiber Optic Communication Technology, 2011, 1st Edition, Pearson, USA
Reference Books	
1.	H. J. Pain, The Physics of vibrations and waves, 2013, 6th Edition, Wiley Publications, India.
2.	R. A. Serway, J. W. Jewett, Jr, Physics for Scientists and Engineers with Modern Physics, 2019, 10th Edition, Cengage Learning, USA.
3.	K. Krane, Modern Physics, 2020, 4th Edition, Wiley Edition, India.
4.	M.N.O. Sadiku, Principles of Electromagnetics, 2015, 6th Edition, Oxford University Press, India.
5.	W. Silfvast, Laser Fundamentals, 2012, 2nd Edition, Cambridge University Press, India.
Mode of Evaluation: Written assignment, Quiz, CAT and FAT	

Recommended by Board of Studies	26-06-2021		
Approved by Academic Council	No. 63	Date	23-09-2021

BPHY101P	Engineering Physics Lab	L T P C
		0 0 2 1
Pre-requisite	**12th or equivalent**	**Syllabus version**
		1.0

Course Objectives

To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.

Course Outcome

At the end of the course the student will be able to

1. Comprehend the dual nature of radiation and matter by means of experiments.
2. Get hands-on experience on the topics of quantum mechanical ideas in the laboratory.
3. Apply low power lasers in optics and optical fiber related experiments.

Indicative Experiments

1.	To determine the dependence of fundamental frequency with the length and tension of a stretched string using sonometer.
2.	To determine the characteristics of EM waves using Hertz experiment
3.	To determine the wavelength of laser source (He-Ne laser and diode lasers of different wavelenqths) usinq diffraction qratinq
4.	To demonstrate the wave nature of electron by diffraction through graphite sheet
5.	To determine the Planck's constant using electroluminescence process
6.	To numerically demonstrate the discrete energy levels and the wavefunctions using Schrodinqer equation (e.Q., particle in a box problem can be qiven as an assiqnment)
7.	To determine the refractive index of a prism using spectrometer (angle of prism will be qiven)
8.	To determine the efficiency of a solar cell
9.	To determine the acceptance anqle and numerical aperture of an optical fiber
10.	To demonstrate the phase velocity and qroup velocity (simulation)

Total Laboratory Hours **30 hours**

Mode of assessment: Continuous assessment/ FAT/ Oral examination

Recommended by Board of Studies 26.06.2021

Approved by Academic Council No. 63 Date 23.09.2021

BSTS101P	Quantitative Skills Practice I	IL IT Ip IC To To T3 I1.s
Pre-requisite	Nil	I Syllabus version I 1.0

Course Objectives:

1. To enhance the logical reasoning skills of the students and help them improve problem-solving abilities
2. To acquire skills required to solve quantitative aptitude problems
3. To boost the verbal ability of the students for academic and professional purposes

Course Outcomes:

1. Exhibit sound knowledge to solve problems of Quantitative Aptitude
2. Demonstrate ability to solve problems of Logical Reasoning
3. Display the ability to tackle questions of Verbal Ability

Module:1	Logical Reasoning	5 hours

Word group categorization questions
Puzzle type class involving students grouping words into right group orders of logical sense
Cryptarithmetic

Module:2	Data arrangements and Blood relations	6 hours

Linear Arrangement - Circular Arrangement - Multi-dimensional Arrangement - Blood Relations

Module:3	Ratio and Proportion	6 hours

Ratio - Proportion - Variation - Simple equations - Problems on Ages - Mixtures and alliqations

Module:4	Percentages, Simple and Compound Interest	6 hours

Percentages as Fractions and Decimals - Percentage Increase / Decrease - Simple Interest - Compound Interest - Relation Between Simple and Compound Interest

Module:5	Number System	6 hours

Number system- Power cycle - Remainder cycle - Factors, Multiples - HCF and LCM

Module:6	Essential grammar for Placement	7 hours

- Prepositions
- Adjectives and Adverbs
- Tense
- Speech and Voice
- Idioms and Phrasal Verbs
- Collocations, Gerunds and Infinitives
- Definite and Indefinite Articles
- Omission of Articles
- Prepositions
- Compound Prepositions and Prepositional Phrases
- Interroqatives

Module:7	Reading Comprehension for Placement	3 hours

Types of questions - Comprehension strateqies - Practice exercises

Module:8	Vocabulary for Placement	6 hours

Exposure to questions related to Synonyms -Antonyms -Analogy - Confusing words - Spellinq correctness

	Total Lecture hours:	45 hours

Text Books)

1. SMART. (2018). *Place Mentor* 1st (Ed.). Chennai: Oxford University Press.
2. Aggarwal R.S. (2017). *Quantitative Aptitude for Competitive Examinations* 3rd {Ed.). New Delhi: S. Chand Publishinq.

3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,* 1st (Ed.) Banqalore: McGraw-Hill Education Pvt. Ltd.
Reference Books	
1.	Sharma Arun. (2016). *Quantitative Aptitude,* tn(Ed.). Naida: McGraw Hill Education Pvt. Ltd.
Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)	
Recommended by Board of Studies I 28.06.2021	
Approved by Academic Council I No. 63 I Date I 23.09.2021	

BEEE204L	Signals and Systems	L	T	P	C
		2	1	0	3
Pre-requisite	**BMAT102L**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand the mathematical representations of signals and systems.
2. Understand the limitations of discrete time representations of continuous time signals.
3. Impart the ability to compute and analyze the solutions of continuous and discrete LTI system using time and frequency domains techniques.

Course Outcomes

On completion of this course, the students will be able to

1. Perform signal transformations on continuous and discrete - time signals and systems.
2. Apply convolution integrals and convolution sums to obtain response of LTI systems.
3. Apply frequency domain techniques to obtain steady state response of the continuous and discrete time LTI system.
4. Ability to elucidate the limitations of discrete representations of continuous time signals using sampling theorem.
5. Apply Laplace and Z-Transform techniques to analyze LTI systems.

Module:1	**Fundamentals of Signals**	**6 hours**
Representation of continuous and discrete-time signals; classification of signals; transformation of independent variables; operations on signals; Nyquist sampling theorem		
Module:2	**Fundamentals of Systems**	**5 hours**
Representation of continuous and discrete-time systems, static and dynamic, linear and non-linear, time variant and time invariant, causal and non-causal, stable and unstable, invertible and non-invertible systems; block diagram representation and interconnection of systems		
Module:3	**Analysis of LTI Systems**	**6 hours**
Properties of systems; Impulse response of continuous and discrete time LTI systems; Response of LTI systems using convolution integrals and convolution sum		
Module:4	**Fourier analysis of Continuous-time LTI Systems**	**7 hours**
Response of LTI systems to continuous complex exponentials; Representation of continuous time periodic and aperiodic signals using Fourier series and Fourier transform, properties; Frequency spectrum analysis and response of LTI systems		
Module:5	**Fourier analysis of Discrete-time LTI Systems**	**7 hours**
Response of LTI systems to discrete complex exponentials; Representation of discrete time periodic signals and aperiodic signals using Fourier series and Fourier transform, properties; Frequency spectrum analysis & response of LTI systems		
Module:6	**Sampling and Reconstruction of Signals**	**4 hours**
Sampling: Reconstruction with interpolation, effects of aliasing in time and frequency domains		
Module:7	**Laplace and Z-Transform Analysis**	**8 hours**
Laplace transform: region of convergence and characterization of LTI systems, mapping of s-plane to z-plane; Z-transform: region of convergence, power series expansion and partial fraction expansion; Characterization of LTI systems		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1.	Alan V. Oppenhein, Alan S. Willsky and S. Hamid, Signals and Systems, 2016, 2nd Edition, Pearson Education

2.	Simon Haykin, Signals and Systems, 2021, 2nd Edition, John Wiley			
Reference Books				
1.	R. F. Ziemer, W. H. Tranter and D. R. Fannin, Signals and Systems - Continuous and Discrete, 2014, 4th Edition, Prentice Hall			
2.	Luis F. Chaparro, Aydin Akan, Signals and Systems, 2018, 3rd Edition, Academic Press			
3.	Edward Kamen, Bonnie S.Heck, Fundamentals of Signals and Systems Using the Web and MATLAB, 2014, 3rd Edition, Pearson Education			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies		19-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BEEE205L	Electronic Devices and Circuits	L	T	P	C
		2	0	0	2
Pre-requisite	**BECE101L, BECE101P**	**Syllabus version**			
		1.0			

Course Objectives

1. Familiarize with the semiconductor circuit components of electronics.
2. Describe the detailed study of discrete electronic circuits with amplifiers as a demonstration vehicle.
3. Define the small-signal model extraction and analysis of modern electronic circuits.

Course Outcomes

On completion of this course, the students will be able to:

1. Solve diode circuits for various applications.
2. Analyze and design BJT and MOSFET DC circuits and their amplifier configurations.
3. Interpret frequency response of amplifiers.
4. Identify the impact of negative feedback in amplifier design.

Module:1	**Diode Circuits**	**4 hours**
Inspiration to electronics, real life applications, diode equation, diode Circuits: clippers, clampers, rectifiers with and without filters, regulated power supplies, multiple diode circuits.		
Module:2	**BJT DC Analysis**	**4 hours**
BJT structure and characteristics, current gains, h-parameters, load line, operating point analysis, DC analysis and biasing circuits.		
Module:3	**BJT Amplifiers**	**5 hours**
Small signal analysis of BJT amplifiers, calculation of gain, input impedance, output impedance, Basic BJT (common emitter, common collector and common base) amplifiers, emitter degeneration.		
Module:4	**MOSFET DC Analysis**	**3 hours**
MOSFET structure and characteristics, h-parameters, load line, operating point analysis, DC analysis and biasing circuits.		
Module:5	**MOSFET Amplifiers**	**4 hours**
Small signal analysis of MOSFET amplifiers, calculation of gain, input impedance and output impedance, basic MOSFET (common source, common drain and common gate) amplifiers, source degeneration.		
Module:6	**Frequency Response**	**4 hours**
Amplifier frequency response, system transfer functions, frequency response of transistor amplifier with circuit capacitors, high frequency response of the MOSFET, high-frequency response of BJT.		
Module:7	**Feedback Amplifiers**	**4 hours**
Basic concepts of feedback, negative feedback advantages and types: Voltage/Current series/shunt feedback configurations, multistage amplifiers.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book

1.	Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits - Theory and Applications, 2017, 7th edition, Oxford University Press

Reference Books

1.	Boylestad, Nashelsky, Electronic Devices and Circuit Theory, 2017, 11th edition, Pearson
2 3	D. A. Neaman, Microelectronics-Circuit Analysis and Design, 2016, 4th edition, McGraw Hill

	B. Razavi, Fundamentals of Microelectronics, 2017, 2nd edition, Wiley			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies	19-02-2022			
Approved by Academic Council	No. 65	Date	17-03-2022	

BEEE205P	Electronic Devices and Circuits Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BECE101L, BECE101P**	**Syllabus version**			
		1.0			

Course Objectives

1. Comprehend the knowledge on the characteristics of diode, BJT and MOSFET.
2. Exposure and skills to develop different types of amplifiers using BJT and MOSFET.

Course Outcomes

1. Analyze the characteristics of diode and BJT/MOSFET.
2. Design and analyze the application of BJT/MOSFET as an amplifier.

Indicative Experiments

1.	Analyze the characteristics of PN junction diode
2.	Design of clipper circuits for a desired bias voltage
3.	Design of clamper circuits for a desired bias voltage
4.	Realization of logic gates using PN junction diode
5.	Analyze the transistor characteristics under CE/CC/CB configurations
6.	Measure the DC operating voltages and currents for a BJT biased circuit
7.	Measure the DC operating voltages and currents for a MOS transistor biased circuit
8.	Design and construct RC coupled amplifier for a desired gain
9.	Design and construct Common Collector BJT amplifier
10.	Design and construct Common Source MOSFET amplifier
11.	Frequency response of BJT amplifier using coupling capacitor
12.	Design of multistage amplifiers for a desired gain
	Total Laboratory Hours **30** hours

Mode of assessment: Continuous assessment, FAT

Text Book

1. Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits - Theory and Applications, 2017, 7th edition, Oxford University Press

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2033

BEEE206L	Digital Electronics	L	T	P	C
		3	0	0	3
Pre-requisite	**BECE101L, BECE101P**	**Syllabus version**			
		1.0			

Course Objectives

1. Comprehend the Hardware Description Language (HDL) for digital circuits.
2. Design, simulate and realize the building blocks of digital systems.
3. Analyze combinational and sequential circuit for digital system applications.

Course Outcomes

On completion of this course, the students will be able to

1. Develop digital logic circuits and apply to solve real world applications.
2. Design and analyze digital circuits using Verilog HDL.
3. Design and implement combinational circuits, sequential circuits and programmable logic devices.
4. Analyze and synthesize complex digital modules and circuits for various applications.
5. Able to identify and prevent various hazards and timing problems in a digital design.

Module:1	**Digital Fundamentals and Circuits**	**5 hours**

Digital design: Canonical and standard forms; Karnaugh Maps; Product of Sums (POS) and Sum of Products (SOP) simplification, Don't care conditions; Realization of logic circuits using NAND and NOR gates

Module:2	**Hardware Description Language**	**5 hours**

Verilog HDL: Verilog operators; Levels of design description; Concurrency, Gate level modelling, Data flow modelling, Behavioural modelling; Test benches

Module:3	**Combinational Circuits**	**7 hours**

Combinational circuits: Analysis and design procedures; Circuits for arithmetic operations; Code converters; Decoders and encoders; Multiplexers and De-multiplexers; Parity generator; Magnitude comparator; Design of seven segment display

Module:4	**Sequential Circuits**	**8 hours**

Sequential circuits: Design of sequential modules; SR, D, T and J-K Latches/Flip-flops; Shift registers; Counters; Basic state machine concepts; Mealy/Moore Models, State minimization, State assignment, Circuit Implementation

Module:5	**HDL for Combinational and Sequential Circuits**	**4 hours**

HDL based design: Blocking and non-blocking assignment statement, Procedural assignment statement; Combinational circuits using dataflow and structural modelling; Sequential circuits using behavioural modelling

Module:6	**Asynchronous Sequential Circuits**	**7 hours**

Analysis Procedure; Stable and Unstable states, output specifications, State reduction, Race free assignments, Hazards; Essential Hazards, Design of Hazard free circuits

Module:7	**Memory and Programmable Logic Devices**	**7 hours**

Basic Memory Structures: ROM, PROM, EPROM, EEPROM, RAM; Static and Dynamic RAM; Programmable Logic Devices (PLD); Programmable Logic Array (PLA), Programmable Array Logic (PAL), Implementation of Combinational Logic using PLA and PAL; Field Programmable Gate Array (FPGA)

Module:8	**Contemporary issues**	**2 hours**

	Total Lecture hours:	**45 hours**

Text Books				
1	Floyd, Thomas L., Digital Fundamentals, 2017, 11th Edition, Pearson Education			
2	M Morris Mano, Michael D. Ciletti, Digital design: with an introduction to the Verilog HDL, VHDL, and system Verilog, 2017, 6th Edition, Pearson Education			
Reference Books				
1	Roth, Charles, Lizy K. John, and Byeong Kil Lee, Digital systems design using Verilog,2017, 1st Edition, Cengage India Private Limited			
2	Stephen, Brown, and Vranesic Zvonko, Fundamentals of digital Logic with Verilog design, 2017, 2nd Edition, McGraw Hill Education			
Mode of Evaluation: CAT, Quiz, Assignments, FAT				
Recommended by Board of Studies		19-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BEEE206P	Digital Electronics Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BECE101L, BECE101P**	**Syllabus version**			
		1.0			

Course Objectives

1. Create various building blocks of digital systems.
2. Comprehend and execute the CAD tools to design combinational and sequential circuits.

Course Outcomes

On completion of this course, the students will be able to

1. Design and construct various combinational circuits using gates/MSI components.
2. Design and analyze sequential circuits.
3. Implement various combinational and sequential circuits using Verilog HDL code.

Indicative Experiments

1	Simplify the given Boolean expression and verify using logic gates/Universal gates
2	Design and verification of Half-Subtractor and Full-Subtractor using logic gates
3	Design and implementation of code converters
4	Design and implementation of magnitude comparators using logic gates/ICs
5	Design and verification of given logic function using multiplexer ICs
6	Design and verification of latches
7	Perform the logic operations using Verilog operators
8	Design and verification of Half-adder and Full-adder using Verilog structural modeling
9	Design and verification of priority encoder using Verilog behavioural modelling
10	Design and verification of shift registers using Verilog HDL
11	Design and verification of 4-bit binary up/down counter with load enable
12	Design of arithmetic circuits using Verilog HDL
	Total Laboratory Hours | 30 hours

Mode of assessment: Continuous assessment, FAT

Text Book

1	M. Morris Mano, Michael D. Ciletti, Digital design: with an introduction to the Verilog HDL, VHDL, and system Verilog, 2017, 6th Edition, Pearson Education

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE207L	Electrical Machines	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE101L, BEEE101P, BEEE202L**	**Syllabus version**			
		1.0			

Course Objectives

1. Comprehend the construction and working principle of electrical machines.
2. Understand and interpret the characteristics of electrical machines.
3. Identify the suitable electrical machines to meet the real time requirements.

Course Outcomes

On completion of this course, the students will be able to:

1. Analyze the force / torque expressions of singly and doubly excited electro mechanical energy conversion systems.
2. Analyze and evaluate the performance characteristics of rotating machines and transformers.
3. Compute the equivalent circuit parameters of single-phase transformer and three phase induction motor.
4. Elucidate the need for starters and the necessity of speed control methods for DC motor and induction motor.
5. Select the appropriate electrical machines for practical applications based on their characteristics.

Module:1	**Principle of Electromechanical Energy Conversion**	**5 hours**

Magnetic circuits; Lorentz's force law; Singly excited systems; Doubly excited systems; Determination of magnetic force / torque from energy and co-energy

Module:2	**DC Machines**	**10 hours**

Construction and working principle: classification; Equivalent circuit; Voltage equations; Windings; losses; DC generator: EMF equation, armature reaction, commutation and use of interpoles; Characteristics; Power stage and efficiency; Applications; DC Motor: Characteristics; Power stage and efficiency; Starting and speed control; Applications; Testing: Direct and indirect methods; Swinburne's test, Hopkinson's test

Module:3	**Transformers**	**9 hours**

Construction and working principle; Classifications; Single phase transformer: EMF equation; No load and load phasor diagram; Equivalent circuit; Losses; Efficiency and voltage regulation; Parallel operation; Testing: load test, OC & SC test, Sumpner's test

Auto transformer: Saving of volume and weight of copper - enhanced efficiency as compared to two winding transformers; Three-phase transformers: Vector groups for various connections; All day efficiency

Module:4	**Asynchronous Machine**	**9 hours**

Three-phase induction motor: Construction, working principle, classification; Production of rotating magnetic field; Torque equation; Torque-slip characteristics; Power stages and efficiency; Types of starters; Speed control methods; Induction generator; Applications; Testing of induction motor: no load and blocked rotor test; Equivalent circuit parameters; Circle diagram; Single-phase induction motor: Double field revolving theory; Self-starting methods: Split-phase type, Shaded stator poles, Capacitor-type; Applications

Module:5	**Synchronous Machine**	**10 hours**

Synchronous Generator (Alternator): Construction, working principle, classification; Winding, concentrated and distributed winding, full pitched coil winding and fractional pitched coil winding, Single layer and double layer winding; Induced EMF; Synchronous reactance; Phasor diagram, voltage regulation; Direct and indirect method: EMF, MMF and ZPF; Synchronization of alternators; Effects of change in excitation and mechanical input; Synchronous Motor: Types; Principle of operation; Methods of starting; V curves and inverted V curves; Hunting and Damper windings; Applications

Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1.	I. J. Nagrath and D. P. Kothari, Electric Machines (Sigma Series), 2017, 5th Edition, McGraw Hill Education
2.	Arthur Egune Fitzgerald, Charles Kingsley, Stephen D Umans, Electric machinery, 2020, 7th Edition, McGraw Hill Education
Reference Books	
1.	Stephen J. Chapman, Electric Machinery Fundamentals, 2012, 6th Edition, McGraw Hill Education
2.	P. C. Sen, Principles of Electric Machines and Power Electronics, 2013, Wiley
3.	*SK Bhattacharya, Electrical Machines, 2017, 4th* Edition, McGraw Hill Education
4.	*M.G. Say, Problems and Solutions in Electrical Machines & Transformers, 2017, 1st e-edition, CBS Publishers*

Mode of Evaluation: CAT, Assignment, Quiz, FAT

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE207P	Electrical Machines Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEEE101L, BEEE101P, BEEE202L**	**Syllabus version**			
		1.0			

Course Objectives

1. To understand the basic requirements for conducting experiments on electrical machines.
2. To gain knowledge and develop skill on testing the electrical machines.

Course Outcomes

On completion of this course, the students will be able to

1. Identify appropriate method of testing for different electrical machines.

2. Design and conduct experiments on electrical machines, interpret data and analyse.

Indicative Experiments	
1	No load, internal and external characteristics of DC shunt generator
2	Comparison of DC shunt Machine performance characteristics using direct and indirect testing methods
3	Determination of performance characteristics of DC series motor
4	Performance characteristics of DC compound motor under cumulative and differential mode
5	Determination of efficiency and voltage regulation of single-phase transformer
6	Determination of equivalent circuit parameters and predetermination of efficiency and voltage regulation of single-phase transformer
7	Load sharing of two identical transformers connected in parallel
8	Load test on three-phase squirrel cage induction machine in generator and motor mode
9	No-load and blocked rotor test of three-phase induction motor
10	Speed control and load test of three-phase wound rotor motor
11	Load test on single-phase induction motor
12	Predetermination of voltage regulation in three-phase alternator by EMF and MMF methods
13	Synchronization of a three-phase alternator to the busbar
14	V and inverted V curves of three-phase synchronous motor
	Total Laboratory Hours **30 hours**

Mode of assessment: Continuous Assessment, FAT			
Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE208L	Analog Electronics	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE205L, BEEE205P**	**Syllabus version**			
		1.0			

Course Objectives

1. Design different types of amplifiers and analyze their responses.
2. Comprehend the characteristics and applications of analog IC's.
3. Design and implement analog circuits for real world applications.

Course Outcomes

On completion of this course, the students will be able to:

1. Interpret the concepts of power amplifiers.
2. Compare and analyze the design aspects of differential amplifiers.
3. Design the frequency of oscillation for different oscillators.
4. Analyze the performance characteristics and applications of Op-Amp.
5. Design ADCs, DACs and timer circuits for engineering applications.

Module:1	**Power Amplifiers**	**6 hours**
Power Amplifiers; Power transistors; Heat sinks; Classes of amplifiers: Class A, B and C power amplifiers, Class AB Push-Pull complementary output stages		
Module:2	**Differential Amplifiers**	**6 hours**
Differential amplifiers: Common mode gain, differential mode gain, cascode and folded cascode differential amplifier, differential amplifier with active loads		
Module:3	**Oscillators**	**6 hours**
Barkhausen criterion for oscillation, Hartley and Colpitts oscillators, Phase shift, Wein bridge and Crystal oscillators, Clapp oscillator		
Module:4	**Op-Amp Characteristics**	**7 hours**
DC Performance of Operational amplifier: Input resistance, Output resistance, Open loop gain, Bias currents, offset currents, offset voltage, common mode rejection ratio, negative feedback Amplifier, closed loop gain, differential amplifier; AC Performance: frequency response, transient response, slew rate		
Module:5	**Op-Amp Applications**	**6 hours**
Linear applications of op-amp: Adder, Subtractor, Averaging amplifier, V to I converter, I to V converter, Differentiator and Integrator; Nonlinear applications: Comparator, Multivibrators, Schmitt trigger, Precision half wave and full wave rectifiers, Peak detector, Wave form generators and Active filters		
Module:6	**Analog and Digital Converters**	**6 hours**
Analog-to-digital converter (ADC): Types of ADC, merits and demerits, Design issues; Digital to Analog converter (DAC): Characterization, Types of DAC, merits and demerits, Design issues; Sample and hold circuits; Voltage-controlled oscillator; Phase locked loop: Operating principle and applications		
Module:7	**Timers and Regulators**	**6 hours**
IC555 Timer, Monostable and Astable modes of operation; Voltage regulators: Fixed and Adjustable voltage regulators, Switching voltage regulators		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1	A.S. Sedra, K.C. Smith, T.C. Carusone, and V. Gaudet, Microelectronics Circuits, 2019, 8th edition, Oxford university press
2	James Fiore, Operational Amplifiers & Linear Integrated Circuits: Theory and Application, 2021, 3rd edition, Dissidents

Reference Books				
1	Albert Malvino and David Bates, Electronic Principles, 2021, 9th edition, McGraw Hill Education			
2	Huijsing, Johan, Operational amplifiers, 2016, 3rd Edition, Springer Netherlands			
Mode of Evaluation: CAT, assignment, Quiz, FAT				
Recommended by Board of Studies		19-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BEEE208P	Analog Electronics Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEEE205L, BEEE205P**	**Syllabus version**			
		1.0			

Course Objectives

1. Comprehensive exposure and skills to develop different types of amplifiers and oscillators.
2. Design and implement the various real-time applications using analog IC's.

Course Outcomes

On completion of this course, the students will be able to:

1. Design of differential amplifiers and oscillator circuits for engineering applications.
2. Design and analyze application of various Op-Amp circuits.
3. Develop and implement timer circuits.

Indicative Experiments

1.	Frequency response of Differential Amplifier
2.	Design of Phase Shift Oscillator for a desired frequency
3.	Design of Wien Bridge Oscillator for a desired frequency
4.	Design of Hartley Oscillator for a stipulated frequency
5.	Measurement of Op-amp characteristics
6.	Design and construct: Inverting and Non-inverting amplifiers, Adder, Subtractor, Integrator, Differentiator
7.	Construct a precision Half-wave and Full-wave rectifier
8.	Design and obtain the frequency response of active filters
9.	Design the Schmitt trigger and Comparator circuits
10.	Design Waveform generators to obtain triangular and sawtooth signal
11.	Design and implement the circuit of DAC/ADC
12.	Design and construct Astable and Monostable multivibrator using 555 Timers

Total Laboratory Hours	**30** hours

Text Book

A.S. Sedra, K.C. Smith, T.C. Carusone, and V. Gaudet, Microelectronics Circuits, 2019, 8th edition, Oxford university press

Mode of assessment: Continuous assessment, FAT

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE301L	Power Electronics	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE203L, BEEE205L, BEEE205P**	**Syllabus version**			
		1.0			

Course Objectives

1. Comprehend the operating characteristics of power electronic devices and their control.
2. Analyze the performance of power converters operating under various loads.
3. Design the power converter along with suitable control technique for different operating conditions.

Course Outcomes

On completion of this course, the student will be able to

1. Identify an appropriate power semiconductor device along with gate drive and protection circuits for a given converter configuration.
2. Analyze the performance of single-phase and three-phase AC-DC converters.
3. Comprehend the operating principle of hard and soft-switching DC-DC converters.
4. Analyze the performance of DC-AC converter with various modulation techniques.
5. Understand the operation of AC-AC converters and their performance.

Module:1	**Power Semiconductor Devices**	**8 hours**

Structure; steady-state V-I characteristics; Turn-ON and Turn-OFF characteristics of power diode, SCR, power MOSFET, IGBT and other; Design of gate drive and snubber circuits; Design of heat sinks; Intelligent Power Modules (IPM); Wide-band gap (SiC and GaN) power devices.

Module:2	**AC-DC Controlled Converters**	**9 hours**

Single phase half and fully controlled converters: Performance analysis with R and RL load under continuous and discontinuous conduction modes, inverter mode operation, harmonics, input power factor; Concepts of PWM and phase-angle control; Effect of source impedance; Three-phase half and fully controlled converter: Performance analysis, harmonics, input power factor; Dual converters.

Module:3	**DC-DC Converters**	**10 hours**

Buck, Boost and Buck-Boost DC-DC converters, design equations, TRC and CLC control strategies; multi-quadrant operation; Cuk, forward and fly-back converters; EMI/EMC issues; Hard and soft-switching, zero-voltage switching (ZVS) and zero-current switching (ZCS) concepts; Quasi-resonant converters.

Module:4	**DC- AC Converters**	**10 hours**

Inverter types, Single phase and three phase voltage source inverters (VSI): analysis under R and RL loads, harmonic analysis; PWM control techniques: Square-wave, sinusoidal, modified sinusoidal and space-vector, selective harmonic elimination; EMI/EMC issues; Multi-level concept; diode clamped, capacitor clamped and cascaded H-bridge MLIs; Comparative features.

Module:5	**AC- AC Converters**	**6 hours**

Single-phase and three-phase AC voltage regulators: Circuit configurations, performance analysis, harmonic analysis; Cyclo-converters; Matrix converters.

Module:6	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**

Text Books	
1.	Muhammad H. Rashid, Power Electronics: Devices, Circuits and Applications, 2017, 4th edition, Pearson Education
2.	Hart, Daniel W, Power electronics, 2011, Tata McGraw-Hill Education
Reference Books	
1.	Mohan, Undeland and Robbins, Power Electronics: Converters, Applications and Design, 2007, 3rd edition, Wiley
2.	L. Umanand, Power Electronics: Essentials and Applications, 2009, Wiley
3.	Agrawal Jai P., Power Electronic Systems - Theory and Design, 2011, Pearson Education
4.	Muhammad H. Rashid , SPICE for Power Electronics and Electric Power, 2012, CRC Press

Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE302L	Digital Signal Processing	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE204L**	**Syllabus version**			
		1.0			

Course Objectives

1. Analyze Linear Time-Invariant systems and frequency response characteristics of discrete time systems.
2. Design IIR filters and FIR filters.
3. Comprehend digital signal processors for real world applications and multi-rate signal processing.

Course Outcomes

On completion of this course, the students will be able to

1. Perform frequency response characteristics and fast computation techniques.
2. Realize the structures of digital systems.
3. Design and implement IIR and FIR filters with real time constraints.
4. Explore real world digital signal processors.
5. Explicate multi-rate signal processing and design of adaptive filters.

Module:1	**Analysis of Signals and Systems**	**4 hours**

Classification; Z-transform: ROC, stability and causality analysis; Effects of sampling and quantization in discrete domain.

Module:2	**Discrete Fourier Transform**	**8 hours**

DTFT - frequency domain sampling; DFT: properties, frequency analysis; Radix-2 FFT algorithms, applications; Realization of filter structures: Direct forms I and II, cascade, parallel and lattice structures.

Module:3	**Design of IIR Filters**	**8 hours**

Design techniques for analog low pass filter: Butterworth and Chebyshev approximations, frequency transformation, approximation of derivatives, Bilinear transformation and impulse invariant technique.

Module:4	**Design of FIR Filters**	**8 hours**

FIR Filter Design: Phase and group delay, design characteristics of FIR filters with linear phase, frequency response, FIR filters using window functions: Rectangular, Hamming, Hanning, Bartlett, Blackman and Kaiser.

Module:5	**Digital Signal Processors**	**6 hours**

Finite word length effects, digital signal processor architectures: TMS320 C series, general purpose processors: fixed point and floating point, MAC, pipelining, addressing modes, typical implementation of DSP algorithms.

Module:6	**Multi-rate Digital Signal Processing**	**5 hours**

Sampling rate conversion, decimation and interpolation, implementation using polyphase filter structures.

Module:7	**Adaptive Filters**	**4 hours**

Design of Wiener and Adaptive filters, applications.

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45**

Text Books

1. John G. Proakis, D. G. Manolakis, Digital Signal Processing Principles, Algorithms and Applications, 2016, 4th edition, Pearson Education.
2. Oppenheim V.A.V and Schaffer R.W, Discrete – time Signal Processing, 2014, 3rd Edition, Pearson.

Reference Books

1. Lawrence R Rabiner and Bernard Gold, Theory and Application of Digital Signal

	Processing, 2016, Pearson Education.
2.	Emmanuel C. Ifeachor, Digital Signal Processing- A Practical Approach, 2011, 2nd edition, Prentice Hall.
3.	Steven W Smith, Digital Signal Processing: A Practical Guide for Engineers and Scientists, 2014, Newnes.
4.	Sanjit K. Mitra, Digital Signal Processing, 2013, 4th edition, Tata McGraw Hill.
Mode of Evaluation: CAT, Assignment, Quiz, FAT	

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE303L	Control Systems	L	T	P	C
		3	0	0	3
Pre-requisites	**BEEE101L, BEEE101P, BMAT102L**	**Syllabus version**			
		1.0			

Course Objectives

1. Introduce the fundamentals of physical systems modelling and control of linear time invariant systems.
2. Teach the practical control system design with realistic system specifications.
3. Impart knowledge of state variable models and state feedback design.

Course Outcome

On the completion of this course, the student will be able to:

1. Formulate mathematical models of the physical systems.
2. Analyze the system performance in time and frequency domains.
3. Determine the stability of linear time invariant system in time and frequency domains.
4. Design compensators and controllers to meet the performance specifications.
5. Perform state space analysis and design state feedback control.

Module:1	**Systems and their Representations**	**6 hours**
Basic elements in control systems: open loop and closed loop, transfer functions of mechanical, electrical and electro-mechanical systems, electrical analogous systems; Block diagram reduction, signal flow graphs.		
Module:2	**Time Response Analysis**	**6 hours**
Standard test signals, time response of first and second order systems, time domain specifications; Steady state error, static error constants and system type.		
Module:3	**Stability Analysis and Root Locus**	**6 hours**
Stability: concept and definition, characteristic equation, location of poles, Routh Hurwitz criterion; Root locus technique: construction, properties and applications.		
Module:4	**Frequency Response Analysis**	**6 hours**
Frequency domain specifications; Bode plot, Polar plot; Correlation between frequency domain and time domain specifications.		
Module:5	**Stability in Frequency Domain**	**5 hours**
Relative stability: gain margin, phase margin; stability analysis using frequency response methods; Nyquist stability criterion.		
Module:6	**Compensators and Controllers**	**7 hours**
Realization of basic compensators, cascade compensation in time domain and frequency domain, feedback compensation, design of lag, lead, lag-lead series compensators using Bode plot; P, PI and PID controllers in frequency domain.		
Module:7	**State Space Analysis**	**7 hours**
Concepts of state variable and state model, solution of state equation, state space to transfer function conversion, state space decomposition methods, controllability, observability, pole placement control, observer design.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1.	Norman S. Nise, Control System Engineering, 2019, 8th Edition, John Wiley & Sons
2.	Farid Galnaraghi, Benjamin C. Kuo, Automatic Control System, 2017, 9th Edition, McGraw-Hill Education

Reference Books

1.	K. Ogata, Modern Control Engineering, 2016, 5th Edition, Pearson
2.	R.C. Dorf & R.H. Bishop, Modern Control Systems, 2017, 13th Edition, Pearson

	Education			
3.	M. Gopal, Control Systems- Principles and Design, 2016, 4th Edition, Tata McGraw Hill			
4.	J. Nagrath and M. Gopal, Control System Engineering, 2018, 6th Edition, New Age International Publishers			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies		19-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BEEE303P	Control Systems Lab	L	T	P	C
		0	0	2	1
Pre-requisites	**BEEE101L, BEEE101P, BMAT102L**	**Syllabus version**			
		1.0			

Course Objectives

1. Develop transfer function and state space models of physical systems.
2. Design and implement a PID controller/State feedback controller/ Lag/Lead/Lag-lead compensators.

Course Outcomes

On the completion of this course, the student will be able to:
1. Design feedback control for meeting system specifications.
2. Analyze the stability and response of linear time invariant systems.
3. Perform the time and frequency domain analyses of first and second order systems.

Indicative Experiments

1.	Simulation study of block diagram reduction technique
2.	Determination of time domain specifications
3.	Study of first and second order electrical networks
4.	Stability analysis of linear systems
5.	PID controller design using Bode plot
6.	PID controller design using root locus
7.	Compensator design in frequency and time domains
8.	Analysis of controllability and observability properties of a system
9.	Lag compensator design for linear servo motor for speed control application
10.	Pole placement controller design for inverted pendulum
11.	PD controller design for position control of servo plant
12.	Cascade control design for ball and beam system
13.	PID controller design for magnetic levitation system
14.	Determination of transfer function of separately excited DC generator
15.	Identification of transfer function of field-controlled separately excited DC Motor
16.	Controller realization from MATLAB / SIMULINK using Embedded Coder
	Total Laboratory Hours | 30 hours

Mode of assessment: Continuous assessment, FAT

Text Book

1. Norman S. Nise, Control System Engineering, 2019, 8th Edition, John Wiley & Sons

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE304L	Power Systems Engineering	L	T	P	C
		3	1	0	4
Pre-requisite	**BEEE203L**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand and distinguish various power generation, transmission and distribution systems.
2. Design and analyze the performance of the transmission and distribution systems.
3. Evaluate the various electricity tariffs and power factor correction at consumer premises.

Course Outcomes

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

1. Understand and comprehend the concept of various conventional power generation systems
2. Compute and analyze the transmission line parameters.
3. Design electrical equivalent models and analyze the performance of transmission & distribution systems.
4. Design and analyze the number of string insulators and line sag for overhead lines.
5. Compute various electricity tariff schemes and analyze power factor improvement methods.

Module:1	**Power Generation**	**6 hours**

Power system structure; Comparison between AC and DC power supply; Classification of power generation systems; Conventional power generation: Thermal, hydel, nuclear and pumped storage scheme.

Module:2	**Transmission Line Parameters**	**10 hours**

Transmission line parameters: Resistance, inductance and capacitance of single and three phase lines, single and double circuits, symmetrical and unsymmetrical conductor spacing; Transposition of conductors; Method of GMD; Bundled conductors; Effect of earth on transmission line capacitance; Skin and proximity effects; Interference with neighboring circuits.

Module:3	**Representation of Power System Components**	**7 hours**

Single-phase representation of balanced three-phase networks; One-line diagram; Modeling of power system components; Impedance and reactance diagram; Per Unit (PU) system; Complex power.

Module:4	**Performance of Transmission Line**	**10 hours**

Voltage regulation, Transmission efficiency; Representation of transmission lines: Short, medium and long lines; ABCD constants; Ferranti effect; Corona: Critical Disruptive Voltage (CDV), practical importance; Surge impedance and surge impedance loading; Tuned power lines; Power flow through a transmission line.

Module:5	**Mechanical Design of Overhead Transmission Lines**	**10 hours**

Line supports and conductors; Insulators: types of insulators, string insulator and string efficiency, potential distribution over a string insulator, methods of improving of string efficiency, line sag and tension: wind and ice loading effect, string chart, sag template, vibration dampers; Comparison between overhead line and underground cables, types of underground cables and its construction.

Module:6	**Distribution Systems & Substations**	**8 hours**

Distribution System: Classification, section and size of feeders, schemes of distributor connections AC distributors; Substation design: Classification based on service and design, equipment, types of bus bar arrangements, Key diagram of 33/11 kV and 11 kV/415 V substation, optimal Substation location, earthing of substation, methods of neutral grounding.

Module:7	**Tariff and Power Factor Correction**	**7 hours**
Load curve; Tariff: Characteristics and types; Power factor: Causes of low power factor, power factor improvement and equipment, calculation of power factor capacitance rating.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Books	
1	D. P. Kothari, I. J. Nagrath, Power System Engineering, 2019, 3rd edition, McGraw-Hill Education
Reference Books	
1	John J. Grainger, William D. Stevenson, Gary W. Chang, Power System Analysis, 2016, McGraw-Hill Education
2	CL Wadhwa, Electrical Power Systems, 2017,7th Edition, New Age publication
3	Geoffrey Stokes, "Handbook of Electrical installation Practice", 2014, 4th Edition, Blackwell Publishing Company
Mode of Evaluation: CAT, Assignment, Quiz, FAT	

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE305L	Measurements and Instrumentation	L	T	P	C
		2	0	0	2
Pre-requisite	**BEEE203L**	**Syllabus version**			
		1.0			

Course Objectives

1. Comprehend the operating principle of electrical and electronic measurement systems.
2. Design different measuring instruments for specific applications.
3. Implement data acquisition systems for various engineering applications with virtual Instrumentation.

Course Outcomes

On completion of this course, the students will be able to

1. Understand the constructional features of measurement system and evaluate the errors in the process.
2. Design meters for measurement of various electrical variables.
3. Design bridges for measurement of various electric circuit constants.
4. Analyze and apply various transducers for measurement process.
5. Analyze the working of digital instruments and develop a Virtual Instrumentation system through LabVIEW.

Module:1	**Characteristics of Measurements**	**4 hours**

Functional elements of an instrument; Static and dynamic characteristics of zero and first order instruments; Sources of error in measurement; Techniques for reducing error; Loading effect of instruments; Statistical evaluation of measurement data; Calibration and standards.

Module:2	**Electrical and Electronic Instruments**	**4 hours**

Classification of instruments; Working principle of potentiometer; Design of analog voltmeter, ammeter using PMMC and MI; Ohm meter; Power factor meter; Q meter; Single phase wattmeter; analog energy meter; Instrument transformers.

Module:3	**D.C bridges**	**3 hours**

Design of deflection bridges: Wheatstone bridge, Kelvin bridge, Kelvin double bridge and their merits and demerits.

Module:4	**A.C bridges**	**3 hours**

Maxwell bridge, Anderson bridge, Schering Bridge, Wien Bridge and their Merits and Demerits.

Module:5	**Transducers and Display devices**	**5 hours**

Classification of transducers; Selection of transducers; Resistive, capacitive and inductive transducers; Piezoelectric and digital displacement transducers; Photo tube; Photo multiplier tube; Working principle and specifications of Analog CRO, LED and LCD.

Module:6	**Digital Instruments**	**5 hours**

Comparison of analog and digital techniques; Digital voltmeter; Multimeters; Energy meter; Digital CRO; Frequency counters; Measurement of frequency and time interval; Extension of frequency range; Automation in digital instruments: Automatic polarity indication, automatic ranging, automatic zeroing, fully automatic digital instruments; Computer controlled test systems; Virtual instruments.

Module:7	**Data acquisition**	**4 hours**
Elements of digital data acquisition system: Multiplexing, data loggers; Computer controlled instrumentation; IEEE 488 bus; DAQ cards and accessories: NI ELVIS; Interfacing sensors and actuators to LabVIEW; Applications of LabVIEW		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Books	
1.	Sawhney, A. K., and Puneet Sawhney. A course in Electrical and Electronic Measurements and Instrumentation, 19th Edition, 2016, Dhanpat Rai & Company
2.	Jennings, Richard, and Fabiola De La Cueva. LabVIEW graphical programming, 2020, McGraw-Hill Education
Reference Books	
1.	David A. Bell, Electronic Instrumentation and Measurements, 2013, Oxford University Press
2.	Albert D. Helfrick, William David Cooper, Modern electronic instrumentation and measurement techniques, 2016, Pearson India Education
3.	Ernest Doebelin, Dhanesh Manik, Measurement Systems, 2017, McGraw Hill Education
4.	E. W. Golding, F. C. Widdis, Electrical Measurements and Measuring Instruments, 2019, 6th Edition, Medtech
5.	Kalsi, H. S. Electronic Instrumentation, 3rd edition, 2018, Tata McGraw-Hill Education

Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE305P	**Measurements and Instrumentation Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Pre-requisite	**BEEE203L**	**Syllabus version**			
		1.0			

Course Objectives

1. Design and development of measurement systems.
2. Impart practical knowledge on handling instruments and modern tools.

Course Outcomes

On completion of this course, the student will able to:

1. Perform calibration of electrical measurement systems.
2. Measure various electrical and physical parameters.
3. Develop efficient measurement systems using LabVIEW.

Indicative Experiments

1.	Calibration of single-phase Wattmeter and Energy meter
2.	Torque measurement using Strain gauge
3.	Design of inductance measurement bridge circuit
4.	Design of capacitance measurement bridge circuit
5.	Measurement of resistance using Wheatstone & Kelvin double bridge
6.	Measurement of temperature using RTD and Thermocouple
7.	Arithmetic operations For loop and ‘While’ loop in LabVIEW
8.	Programming using Case structures, Arrays and Clusters
9.	Programming using Sub VI
10.	Develop a VI to read LVDT output voltage using USB 6221
11.	Development of virtual meter through data acquisition using LabVIEW
12.	Develop a VI to activate an alarm for a pre-set value

Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment, FAT

Text Book

Sawhney, A. K., and Puneet Sawhney. A course in Electrical and Electronic Measurements and Instrumentation, 19th Edition, 2016, Dhanpat Rai & Company

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE306L	Power Systems Analysis	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE304L**	**Syllabus version**			
		1.0			

Course Objectives

1. Familiarize with the modelling of components for power system studies.
2. Apply the concepts to design and construct the power system.
3. Design and develop protection schemes for the secured and reliable power grid operation.

Course Outcomes

On completion of this course, the students will be able to:

1. Formulate the network matrices and compute load flow solutions for power systems.
2. Identify and analyze different types of faults to calculate the transient rating of protection devices.
3. Examine different power system stability issues and apply appropriate solution methods.
4. Design and implement protection schemes for power system.
5. Differentiate the working of a conventional SCADA and wide area monitoring system in a power grid.

Module:1	**Power System Network Modelling**	**6 hours**

Need for system analysis in planning and operation of power system; distinction between steady state and transient state; general aspects of power flow, short circuit and stability analysis; Admittance (Y_{BUS}), sparse matrix and impedance (Z_{BUS}) matrix; Equivalent circuit of transformer with off-nominal tap ratio; Phase shifting transformers.

Module:2	**Load Flow Analysis**	**7 hours**

Problem definition; Derivation of power flow equation; Bus classification; Power flow, Newton-Raphson and fast decoupled methods; DC load flow; P-V bus adjustment; computation of slack bus power; transmission loss and line flows.

Module:3	**Symmetrical Short Circuit Analysis**	**7 hours**

Need for short circuit study; Approximations in modeling; Short circuit capacity; Symmetrical short circuit analysis; Algorithm for short circuit studies; Fault calculations using Z_{BUS}.

Module:4	**Unsymmetrical Short Circuit Analysis**	**6 hours**

Symmetrical component transformation; Positive, negative and zero sequence impedances; Unsymmetrical Faults; L-G, L-L and L-L-G fault analysis using sequence networks.

Module:5	**Stability Analysis**	**6 hours**

Swing equation in state space form; Equal area criterion; Critical clearing angle and time; Voltage stability analysis.

Module:6	**Real-time Monitoring and Control of Power Systems**	**6 hours**

Requirements for monitoring control and operation; Dynamics and control time scales; Supervisory Control and Data Acquisition (SCADA) system; Concepts of synchrophasors; Wide Area Monitoring Systems (WAMS); Phasor Measurement Units (PMUs); Augmentation of Wide Area Monitoring Systems (WAMS) for real time control with SCADA systems.

Module:7	**Power System Protection**	**5 hours**

Power system protection concepts and relaying; Electromagnetic and static relays; Overcurrent and differential protection; Distance protection; Relay coordination.

Module:8	**Contemporary Topics**	**2 hours**

	Total Lecture hours:	**45 hours**

Text Books				
1.	John J. Grainger, William D. Stevenson, Jr, Gary W Chang, Power System Analysis, 2016, Tata McGraw Hill Education			
2.	Hadi Saadat, Power System Analysis, 2015, Tata McGraw Hill Education			
Reference Books				
1.	Ulf Hager, Christian Rehtanz, Nikolai Voropai, Monitoring Control and Protection of Interconnected Power Systems, 2014, Springer			
2.	D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, 4th Edition, 2011, Tata McGraw Hill Education			
Mode of Evaluation: CAT, Quiz, Assignments, FAT				
Recommended by Board of Studies		19-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BEEE306P	Power Systems Analysis Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEEE304L**	**Syllabus version**			
		1.0			

Course Objectives

1. Represent and apply the network models of different power system components for steady state and dynamic simulations.
2. Design a protection scheme for power grids based on the results of short circuit analysis.
3. Carryout transient studies to assess the stability of power system following disturbances from the power grid.

Course Outcomes

On completion of this course, the students will be able to

1. Estimate the reactive power requirement of a typical AC system to operate within nominal voltage and power factor limits.
2. Develop and apply load flow analysis to an electrical power grid and interpret the results.
3. Calculate the circuit breaker ratings from the results of short circuit analysis.

Indicative Experiments

1.	Calculation of transmission line parameters for short, medium and long lines
2.	Ferranti effect on long transmission lines
3.	Reactive compensation requirement for power systems
4.	Determination of Y_{BUS} and Z_{BUS} matrices
5.	Load flow analysis of power system
6	Load flow analysis using DC load flow model and calculation of ATC using repeated power flow
7.	Symmetrical short circuit analysis
8.	Unsymmetrical short circuit analysis
9.	Transient stability analysis of SMIB system
10.	IDMT characteristics of overcurrent relays
11	Differential protection of transmission lines
	Total Laboratory Hours **30** hours

Mode of assessment: Continuous assessment, FAT

Text Book

1. John J. Grainger, William D. Stevenson, Jr, Gary W Chang, Power System Analysis, 2016, Tata McGraw Hill Education

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE307L	Electric Drives	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE207L, BEEE207P, BEEE301L**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand the concepts and basic operation of electric drive system.
2. Comprehend open loop and closed loop control operation of electric motor drives.
3. Learn the concepts of vector control and sensor less control of AC motors.

Course Outcomes

On completion of this course, the student will be able to

1. Comprehend the characteristics of electric motor drives.
2. Analyze DC motors characteristics with control techniques.
3. Analyze AC motors with soft starting methods and braking methods.
4. Understand the vector control and sensor less control concepts of AC Motors.
5. Select the appropriate motor drive system for the required load dynamics.

Module:1	**Dynamics of Electric Drives**	**9 hours**

Dynamics of Electric Drives: Types of loads, Multi quadrant operation, Moment of Inertia; Starting and Braking methods; Selection of Motor Power rating: Heating, Classes of Duty, Determination of motor power rating.

Module:2	**DC Motor Drives**	**9 hours**

Factors governing speed and torque of DC motors, Controlled rectifiers-based speed control: single quadrant, two quadrant and four quadrant-controlled DC motor drive; Chopper fed speed control: four quadrant operation; Open loop and Closed loop Control.

Module:3	**Scalar Control of Induction Motor Drives**	**10 hours**

Characteristics and equivalent circuit of poly-phase induction motor; Speed control techniques: Stator voltage control, variable frequency control; Soft starting methods, braking methods; overview of single-phase drives; Kramer's drive, Scherbius drive, doubly fed induction motor drive.

Module:4	**Vector Control of Induction Motor Drives**	**9 hours**

Phasor Diagram, *dq* Modelling, decoupling of torque and flux; Field Oriented control: stator flux-oriented control, rotor-flux-oriented control, magnetizing-flux-oriented control; Direct Torque control; Sensorless control; Estimation techniques.

Module:5	**Synchronous Motor Drives**	**6 hours**

Characteristics; Separate Control Mode; Self-Control Mode; Power factor control; Marginal angle control; BLDC motor control; Switch reluctance motor control.

Module:6	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**

Text Books

1. R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, 2015, 2nd edition, Pearson Education.
2. Bimal K. Bose, Modern Power Electronics and AC Drives, 2005, Prentice Hall, New Jersey.

Reference Books				
1	S. K. Pillai, A First Course on Electrical Drives, 2012, New Age International Publisher			
2	G. K. Dubey, Fundamentals of Electrical Drives, 2010, 2nd edition, Narosa Publications			
3	Raja Singh, Energy Conservation Strategies for Asynchronous Machine Drives, 2021, LAP LAMBERT Academic Publishing			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies		19-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BEEE307P	Power Electronics and Drives Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEEE207L, BEEE207P, BEEE301L**	**Syllabus version**			
		1.0			

Course Objectives

1. Experiment with power electronic converters to determine their operating characteristics.
2. Infer the control strategies of electric drive systems.

Course Outcomes

Upon completing the course, the student will be able to

1. Identify the suitable power electronic converter for various applications.
2. Build DC drives with suitable control techniques.
3. Demonstrate control techniques for poly-phase induction motor drive system.

Indicative Experiments

1.	Design of a Gate drive circuit for SCR / MOSFET / IGBT
2.	Analyze gate pulse logic, modes of operation, verify the input and output waveforms of the single-phase AC-DC controlled converter
3.	Analyze gate pulse logic, modes of operation, verify the input and output waveforms of the three-phase AC-DC controlled converter
4.	Design a pulse-width modulated (PWM) buck/boost dc-dc converter operating in continuous-conduction mode (CCM)
5.	Design and simulate/experiment the single-phase PWM inverter
6.	Analysis gate pulse logic, modes of operation and simulate/experiment the Three-phase inverter
7.	Analyze gate pulse logic, modes of operation and simulate/experiment the AC-AC voltage controller
8.	Analyze gate pulse logic, modes of operation and simulate/experiment the AC-AC frequency converter
9.	Analyze the fundamental blocks in the Speed control of DC motor drive
10.	Performance determination of DC motor drive under dynamic load
11.	Braking of DC motor drive
12.	Performance determination of poly-phase induction motor drive under dynamic load
13.	Speed control of poly-phase induction motor drive using V/f control
14.	Speed control of wound rotor induction motor using static rotor resistance/slip power recovery scheme
15.	Soft starting of poly-phase induction motor using VVFF and VVVF method
16.	Vector control of induction motor drive
17.	Separate control of synchronous motor drive
18.	Self-controlled synchronous motor drive
	Total Laboratory Hours **30 hours**

Mode of assessment: Continuous assessment, FAT

Text Book

1. G. K. Dubey, Fundamentals of Electrical Drives, 2010, 2nd edition, Narosa Publications

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE308L	Communication Systems	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE204L, BEEE208L, BEEE208P**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand the fundamentals of analog and digital communication systems.
2. Comprehend the various communication systems and applications.
3. Analysis of source and channel coding theorems.

Course Outcomes

On the completion of this course, the students will be able to:

1. Demonstrate the concept of modulation.
2. Examine the properties of random processes.
3. Design and analyze transmitters and receivers for analog communication systems.
4. Assess and contrast shift keying and pulse modulation techniques.
5. Understanding the concepts of error correcting codes.

Module:1	**Basics of Communication Systems**	**4 hours**

Communication systems: Importance, elements, block diagram and role of each block, types; Frequency ranges; Bandwidth; Need for modulation; Noises in communication systems.

Module:2	**Random Process and Spectral analysis**	**5 hours**

Bandpass signal and system representation; Random process, stationarity, power spectral density, Gaussian process.

Module:3	**Amplitude Modulation**	**9 hours**

Representation and generation of analog modulation systems: AM, DSB, SSB, VSB; Frequency spectrum; Power relation; Different types of modulators; AM transmitter: Low level and
High level modulation, SSB transmitter; AM demodulators; Characteristics of receivers; TRF Receiver; Super heterodyne receiver; SSB receiver; Choice of IF and oscillator frequencies, AVC, AFC, AGC.

Module:4	**Angle Modulation**	**8 hours**

Representation and generation of frequency (NBFM & WBFM) and phase modulation; Pre-emphasis; De-emphasis; Comparison of AM, FM and PM; Conversion of FM to PM and PM to FM; FM transmitters; FM detection techniques; FM super heterodyne receiver; Diversity reception.

Module:5	**Pulse / Digital modulation systems**	**9 hours**

Pulse modulations: Pulse amplitude modulation, Pulse width modulation, Pulse position modulation; Signal to noise ratio of pulse modulation systems; Pulse code modulation; Delta, Adaptive delta modulation; Shift keying techniques: ASK, FSK, PSK and Probability of error analysis.

Module:6	**Source and Channel Coding**	**8 hours**

Concepts of entropy and source-coding: source coding theorem, Huffman coding; Memoryless channels: types, capacity; Linear block codes; Cyclic codes; Convolutional codes; Viterbi decoding; Reed Solomon codes.

Module:7	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 Hours**

Text Books	
1.	B.P. Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, 2017, 4th Edition, Oxford University Press
2	Simon Haykin, Michael Moher, Introduction to Analog and Digital Communications, 2012, 2nd Edition, Wiley India Pvt Ltd, New Delhi
Reference Books	
1.	Herbut Taub, Donald L. Schilling, Goutam Saha, Principles of communication systems, 2017, 4th Edition, McGraw Hill Education, India
2.	George Kennedy, Bernard Davis, S. R. M Prasanna, Electronic Communication Systems, 2017, 6th Edition, McGraw Hill Education, India
3.	John G Proakis, Masoud Salehi, Digital Communications, 2018, 5th Edition, McGraw Hill Education, India
Mode of Evaluation: CAT, Assignment, Quiz, FAT	

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE309L	Microprocessors and Microcontrollers	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE206L, BEEE206P**	**Syllabus version**			
		1.0			

Course Objectives

1. Emphasize on hardware functionality of Intel 8051 and ARM.
2. Create an essential knowledge of the I/O ports, Timers/Counters, control registers and various types of interrupts.
3. Demonstrate the procedure and methods to interface a microcomputer system to various devices.

Course Outcomes

1. Understand architecture of 8051 microcontroller and its instruction set.
2. Comprehend and develop programs for various blocks of 8051.
3. Design and interface microcontroller based embedded systems.
4. Interpret the architecture of ARM Processor.
5. Analyze the different ARM instructions to solve real-time problems and interface various peripherals.

Module:1	**8-bit Architecture**	**6 hours**

Hexadecimal Arithmetic, Registers, Buses, Microprocessor & Microcontroller; Overview of 8051 Architecture; Program Status Register; Structure of Random-Access Memory; Special function registers; Pin configuration and ports structure of 8051 Microcontroller.

Module:2	**Instruction Set of 8051**	**6 hours**

Data transfer instructions; Arithmetic and Logical instructions; Boolean instructions; Control transfer instruction; Programming 8051 using Assembly and Embedded C; Demonstration of HEX file generation and program execution.

Module:3	**ARM Processor**	**5 hours**

RISC philosophy; Comparison between CISC and RISC; Overview of 32-bit ARM architecture; ARM memory organization; Different modes of ARM processor; Program status register; 3-stage pipeline.

Module:4	**ARM Cortex - M Architecture**	**6 hours**

ARM Cortex-M Organization; Cortex M Registers; Cortex A/M Series; Advanced Microcontroller Bus Architecture (AMBA); Nested vectored interrupt controller.

Module:5	**Instruction Set of ARM Processor**	**8 hours**

Data transfer instructions; Arithmetic and Logical instructions; Multiply instructions; Branches and subroutines; Load/Store instructions; Swap instruction; Pre and Post Indexing; Programming of ARM.

Module:6	**General Purpose I/O, and Circuits**	**4 hours**

General Purpose Input/Output (GPIO); Basic Concepts; Port Circuitry; Peripheral Access In C; Circuit Interfacing; LED & Switch Interface.

Module:7	**Peripherals and Interfacing**	**8 hours**

Display Interface; Timer module; Pulse-width modulation (PWM) Module; Analog-to-Digital conversion; Digital-to-Analog conversion; Programming of peripherals.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1. Muhammad Ali Mazidi, Janice Gillispie *Mazidi, and* Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems: Using Assembly and C, 2018, 2nd Edition, Pearson Education
2. Pyeatt, Larry D, Modern Assembly Language Programming with the ARM Processor, 2016, 1st Edition, Newnes, Elsevier

Reference Books

1. Muhammed Ali Mazidi, Sarmad Naimi , Sepehr Naimi, Arm Cortex-M Assembly Programming for Embedded Programmers: Using Keil, 2020, 1st Edition, Pearson
2. Hohl, William, ARM assembly language: fundamentals and techniques, 2016, 2nd Edition, CRC Press
3. Saurabh Chandrakar, Nilesh Bhaskarrao Bahadure, Microcontrollers and Embedded System Design, 2019, 1st Edition, Dreamtech Press

Mode of Evaluation: CAT, Programming Assignment, Quiz, FAT			
Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE309P	Microprocessors and Microcontrollers Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEEE206L, BEEE206P**	**Syllabus version**			
		1.0			

Course Objectives

1. Familiarize and develop programs for 8051 and ARM processor.
2. Excel and implement various interfacing techniques with processor and controller.

Course Outcomes

1. Develop and demonstrate structured assembly programs using microcomputer.
2. Implement C language programming for processor and controller.
3. Design hardware using microprocessor and microcontroller for real-time applications.

Indicative Experiments

1.	Solve simple arithmetic expressions using 8051 instructions
2.	Transfer of data between different 8051 memories
3.	Introduction to ARM instructions and perform arithmetic and logical tasks
4.	Programming ARM processor using subroutines
5.	Interworking of ARM – THUMB codes
6.	Programming GPIO pins of ARM processor
7.	Generation of delay using timers of ARM processor
8.	Interfacing switch, LED, and buzzer with Cortex - M
9.	Interfacing display devices with controllers
10.	Interface sensors with controller
11.	Generation of wave forms using DAC
12.	Generation of PWM signals for MOSFET switches
	Total Laboratory Hours **30 hours**

Text Book

1. Muhammad Ali Mazidi, Janice Gillispie *Mazidi, and* Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems: Using Assembly and C, 2018, 2nd Edition, Pearson Education

Reference Book

1. Muhammed Ali Mazidi, Sarmad Naimi , Sepehr Naimi, Arm Cortex-M Assembly Programming for Embedded Programmers: Using Keil, 2020, 1st Edition, Pearson Education

Mode of assessment: Continuous assessment, FAT

Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE201L	Electronic Materials	ILITIPIC
		3 0 0 3
Pre-requisite	**NIL**	**Syllabus version**
		1.0

Course Objectives

1. Familiarize the relevant concepts, principles and characteristics of electronic materials.
2. Understand and comprehend the various laws and mechanisms of semiconductor, dielectric and magnetic materials.
3. Analyze and compare the unique properties, characteristics and applications of materials in electronic devices.

Course Outcomes

On completion of this course, the students will be able to:

1. Understand the fundamental physics of electronic materials.
2. Classify and interpret various types of current carrying mechanisms in semiconductor materials.
3. Comprehend the categories of magnetic materials and its characteristics.
4. Analyze the various types of dielectric materials based on the nature of electric field.
5. Distinguish and examine the various optical properties of materials.

Module:1 Physics of Materials **6 hours**

Atomic structure and atomic number, electron spin and Pauli's exclusion principle, bonding and types of solids, concepts of Fermi level, energy bands in solids; Classification of materials - metals, semiconductors and insulators; Potential barrier problems, crystal directions and planes, crystal properties, defects and vacancies.

Module:2 Semiconductor Materials **10 hours**

Classification of semiconductors, doping of semiconductor, temperature dependence, metal-semiconductor junction; Carrier concentration, carrier generation and recombination, Carrier actions, diffusion and conduction equations, continuity equation; Organic semiconductor; Direct and indirect band gaps, optical absorption, Piezo-resistivity; Applications of semiconductor materials: PN junction diodes, BJT, JFET, MOSFET.

Module:3 Magnetic Materials **6 hours**

Classification of magnetic materials, concept of ferromagnetism, saturation magnetization, Curie and Neel temperature; Temperature dependence of conductivity materials; Magnetostriction, magnetic anisotropy, spin-orbit interaction; Superconductivity.

Module:4 Dielectric Materials and Insulation **8 hours**

Requirements of insulating materials: Electrical and molecular properties, dependence of permittivity on temperature, pressure & humidity; Dipole moment and electronic polarization, Clausius-Mossotti equation, polarization mechanisms; Behaviour of dielectrics under static and alternating fields; Frequency dependence; Complex dielectric constants and dielectric loss, bipolar relaxation and characteristics.

Module:5 Optical Properties of Materials **8 hours**

Light propagation in a homogeneous medium, refractive index, group velocity and group index, complex refractive index and light absorption; Light scattering, attenuation in optical fibers; Luminescence, phosphors, Light Emitting Diode (LED), Liquid Colour Display (LCD), electro optic effects.

Module:6 | Semiconductor Nanomaterials	**5 hours**
Flexible energy storage devices, flexible chemical sensors, flexible solar cells	
Module:7 | Contemporary Issues	**2 hours**
Total Lecture hours:	**45 hours**
Text Book(s)	
1.	S.O. Kasap, Principles of Electronic Materials and Devices, 2018, 4m Edition, McGraw Hill Education
2.	Yugang Sung, John A Rogers, William Andrew, Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage/ Harvesting Devices, 2010, 1st Edition, Elsevier
Reference Books	
1.	T.K. Basak, Electrical Engineering Materials, 2012, 1st Edition, New Academic Science Limited
2.	Rolf E. Hummel,Electronic Properties of Materials, 2001, 3ra Edition, Springer
3.	C. S. lndulkar, S. Thiruvengadam, An Introduction to Electrical Engineering Materials,2011, 6th Edition, S. Chand & Company
Mode of Evaluation: CAT, Digital Assignments, Quiz and FAT	
Recommended by Board of Studies | 30-10-2021	
Aooroved bv Academic Council | No. 64 | Date | 16-12-2021	

BEEE202L	Electromagnetic The ry	ILITIPIC
		I 2 11 IO I 3
Pre-requisite	**NIL**	**Syllabus version**
		1.0

Course Objectives:

1. Familiarize with various coordinate systems and electromagnetic vector fields.
2. Impart knowledge on the concepts of electrostatic, magnetostatic and electrodynamic fields.
3. Disseminate concepts related to electromagnetic waves, waveQuides and aoolications of electromaQnetic fields.

Course Outcomes:

On the completion of this course the student will be able to:

1. Identify and implement an appropriate coordinate system for the given electromagnetic field problem.
2. Apply concepts of electrostatics for applications related to electric fields.
3. Apply principles of magnetostatics for computing parameters related to magnetic fields.
4. Understand the concepts of electrodynamic fields and apply Maxwell's equations to electromagnetic wave propagation.
5. Comprehend and analyze the major applications of electromagnetic waves.

Module:1	**Vector Analysis**	**5 hours**

Sources and effects of electromagnetic fields; Review of scalar and vector fields, different coordinate systems: Cartesian, cylindrical and spherical; Coordinate transformation: Differential elements in different coordinate systems, Del-operator, divergence, curl and Qradient; DiverQence theorem; Stoke's theorem

Module:2	**Electrostatic Fields**	**7 hours**

Coulomb's law, electric field intensity, electric flux, Gauss's law, potential due to point, line and surface charge distributions; Continuity equation and relaxation time; Boundary conditions, Laplace, Poisson's equations and solutions; Analytical methods: Variables separable method; Electrostatic energy, capacitance calculations

Module:3	**Magnetostatic Fields**	**7 hours**

Magnetic fields, magnetic flux, Biot-Savart's law, Ampere's law; Magnetic torque and moment; Forces due to magnetic fields; Vector potential; Magnetic boundary conditions; Magnetic energy, inductance calculations

Module:4	**Maxwell's Equations and Time Varying Fields**	**10 hours**

Faraday's law, Lenz's law; Maxwell's equations, displacement current, Maxwell's equations in final forms, time varying fields; Relation between field theory and circuit theory; Applications of electromagnetic conversion; Properties of conductor and dielectrics; Wave equations for free space, wave equations for conductors, skin effect, complex permittivity; Power and Poynting vector and theorem

Module:5	**Uniform Plane Waves**	**10 hours**

Uniform plane wave propagation: Wave equations, transverse nature of uniform plane waves, perpendicular relation between E and H; Electromagnetic waves in charge free region, current free dielectric; Reflection by ideal conductor: Normal incidence, reflection and transmission with normal incidence at another dielectric, plane wave in lossy dielectric;

Wave impedance and propagation constant, depth of penetration, surface impedance and surface resistance		
Module:6	**Applications of Electromagnetics**	**4 hours**
Application of electromagnetic propagation through transmission lines and rectangular waveguides; Wireless power transfer; Electromagnetic interference, electromagnetic compatibilitv		
Module:7	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Matthew N. 0. Sadiku and S. V. Kulkarni, Principles of Electromagnetics, 2015, 5m Edition, Oxford University Press, New York	
Reference Books		
1.	W H Hayt Jr, J A Buck &M Jaleel Akhtar, Engineering Electromagnetics, 2020, gm Edition, McGraw Hill Education	
2.	Mahmood Nahvi & Joseph A. Edminister, Schaum's Outline of Electromagnetics, 2018, 5th Edition, McGraw Hill Education	
3.	Karl E. Lonngren, Sava Savov, Randy J. Jost, Fundamental of Electromagnetic with MATLAB, 2007, 2nd Edition, Scitech Publishing Inc.	
4.	J. Edminister and Vishnu Priye, Electromagnetics, 2017, 2nd Edition, Schaum's Series	
Mode of Evaluation: CAT, Digital Assignments, Quiz and FAT		
Recommended by Board of Studies	30-10-2021	
Approved by Academic Council	No. 64 Date 16-12-2021	

BEEE203L	Circuit Theory	IL IT IP IC
		3 1 0 4
Pre-requisite	BEEE101L,BEEE101P	Syllabus version
		1.0

Course Objectives

1. Familiarize the network topology, theorems and the analysis of three-phase unbalanced systems.
2. Understand the time domain system behaviour using pole zero plot, resonant circuits and to implement different types of passive filters.
3. Evaluate the transient and steady state response of electrical circuits and two port network parameters.

Course Outcomes

At the end of the course, student will be able to:

1. Understand the network topology and to apply the network theorems to estimate the steady state response for a given excitation.
2. Analyse three-phase unbalanced systems in star and delta configurations.
3. Infer and evaluate transient response, steady state response of RL, RC and RLC circuits and network functions.
4. Acquire knowledge about the application of Laplace transform, Fourier series and Fourier transform in the electrical network.
5. Evaluate two port network parameters to simplify the network computations.

Module:1	Network Topology	6 hours

Concept of tree, branch, tree link, incidence matrix, tie-set matrix and loop currents, cut-set matrix and node pair potentials; Duality

Module:2	Network Theorems	10 hours

Network theorems for AC circuits: Superposition, reciprocity, thevenin's, norton's, maximum power transfer and millman's theorem

Module:3	Three-phase Systems	8 hours

Review of balanced system; Unbalanced systems: Delta-connected, three-wire star connected, four-wire star-connected loads; Analysis of unbalanced 3-wire star load: Kirchhoff's law, loop current method, star/delta conversion method using millman's theorem

Module:4	Analysis of Transient Response of Circuits	10 hours

Review of Laplace transformation; Laplace transform of network and time domain solution for RL, RC and RLC networks for AC and DC excitations; Transient behaviour of circuit elements under switching conditions and their representations, evaluation of initial and final conditions in RL, RC and RLC circuits with AC and DC excitations

Module:5	Network Function and Frequency Response	10 hours

Transfer Function; Poles and zeros diagram, time-domain response from pole-zero plot, poles and zeros of network functions and their significance; Stability; Series and parallel resonance: Q factor and bandwidth

Filters: Definitions, classification and characteristics of different filters; Design of passive filters: Low pass filter, hiqh pass filter, band pass filter and band stop filter

Module:6	Fourier Analysis and Its Applications	7 hours

Trigonometric fourier series for non-sinusoidal functions: Circuit analysis; Average power and RMS values using fourier coefficients; Exponential fourier series; Fourier transform for commonly used periodic and aperiodic functions; Circuit analysis in frequency domain

Module:7	Two Port Networks	7 hours

Open circuit impedance parameters, Short circuit admittance parameters, transmission parameters, hybrid parameters; Relationship between parameter sets; Interconnections of two port networks

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	**60 hours**
Text Book(s)		
1.	Charles K Alexander, Matthew Sadiku, Fundamentals of Electric Circuits, 2021, ytn edition, Mc Graw Hill Education	
2.	Ravish. R. Sinah, Network Analysis &Synthesis, 2019, 2na Edition, Mc-Graw Education	
Reference Books		
1.	William Hayt, Jack Hemmerly, Jaime Phillips, Steven Durbin, Engineering Circuit Analysis, 2019, 9th edition, Mc Graw Hill Education	
2.	M.E Van Valkenbera, Network Analysis, 2019, Revised 3r0 Edition, Pearson Publishers	
3.	Abhijit Chakrabarthi, Circuit Theory (Analysis and Synthesis), 2018, 7mRevised Edition, Dhanpat Rai &Co.	
4.	V. K. Mehta, Rohit Mehta, Basic Electrical Engineering, 2017, S Chand Publishers	
5.	Mahmood Nahvi, Joseph Edminister, Electric Circuits, 2018, ytnEdition, McGraw Hill Education	
Mode of Evaluation: CAT, Diaital Assianments, Quiz and FAT		
Recommended by Board of Studies	30-10-2021	
Approved by Academic Council	No. 64	Date 16-12-2021

Course Code	Course Title	L	T	P	C
BEEE210L	Electrical Machine Design	2	1	0	3
Pre-requisite	BEEE207L, BEEE207P	Syllabus version			
		1.0			

Course Objectives

1. Impart knowledge on designing of static and rotating machines based upon fundamental theories
2. Design of transformers and rotating machines
3. Design of cooling system for heavy duty machines and analyze the losses

Course Outcomes

On completion of the course, the student will be able to

1. Familiarize the importance of magnetic, thermal and electric loadings
2. Illustrate the design procedure of rotating machines and transformers
3. Develop the model and analyze the static and rotating machines
4. Analyze the effect of dimensions of the different parts of various electrical machines on the output and losses
5. Examine the design of electrical machines according to standards

Module:1	**Design aspects of Electrical machines**	**6 hours**

Principles of electrical machine design; General design: considerations, specifications of machines; Enclosures for rotating electrical machines; Methods of Cooling; types of ventilation; heating; Rating of machines; Types of duties and ratings; Measurement of temperature rise

Module:2	**Magnetic Circuits Design**	**6 hours**

Magnetic circuit calculations; calculation of total mmf: air gap mmf, Net iron length, mmf for teeth, real and apparent flux densities; Types of iron losses; Magnetic leakage Calculations: Effects of Leakage, Armature Leakage, slot leakage; Magnetic pull

Module:3	**Transformers**	**7 hours**

Core and shell type transformers; Single and three phase transformers; Output equations-volts per turn; Core area and weight of iron and copper; Optimum design; Design of core: stepped and square core; Choice of flux density; Design of windings; Window space factor; Window dimensions; Design of tank and cooling tubes of transformers

Module:4	**DC Machines**	**8 hours**

Output equations: Main dimensions, Choice of Specific Electric and Magnetic Loading; Selection of number of poles: choice of number of poles, core length; Design of Armature; Armature Windings; Design of field system; Design of shunt and series field winding; Design of commutator and brushes; Design of Interpoles

Module:5	**Induction Machines**	**8 hours**

Constructional details of squirrel cage and slip ring motors; output equation; main dimensions choice of specific loadings; Stator Design; Rotor Design: Length of air gap; Design of rotor bars and slots; Design of end rings; Losses and Efficiency

Module:6	**Synchronous Machines**	**8 hours**

Output equations; Choice of Electrical and Magnetic Loading; Design of salient pole machines – Short circuit ratio; Shape of pole face; Design of rotor and damper winding; Design of field winding; Design of turbo alternators; Rotor design

Module:7	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1. K.G.Upadhyay, “Design of Electrical Machines”, New Age International, 2015

2.	A.K.Sawhney, “A Course in Electrical Machine Design”, Dhanapat Rai and Sons, New Delhi, 2015
Reference Books	
1.	S.K.Sen, “Principles of Electrical Machine Design with Computer Programmes”, Oxford and IBH publishing Co.Pvt Ltd.,New Delhi, 2011
2.	V.N.Mittle and A.Mittle, “Design of Electrical Machines”, Standard Publications Distributors, NewDelhi, 2005
Mode of Evaluation: CAT, Quiz, Assignments, FAT	

Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE211E	VLSI Design	2	0	2	3
Pre-requisite	BEEE206L, BEEE206P	Syllabus version			
		1.0			

Course Objectives

1. Comprehend the digital VLSI concepts, circuit design and principles
2. Understand the design concepts and architecture underlying modern complex VLSI
3. Gain sufficient knowledge on the methodologies and design techniques related to digital integrated circuits

Course Outcomes

On completion of this course, the students will be able to

1. Design digital logic circuits using CMOS logic
2. Analyze and design digital logic circuits for optimal delay and power
3. Design and implement combinational logic circuits using different logic styles
4. Design and develop complex arithmetic circuit architectures for various real-time applications

Module:1	**VLSI Design Methodology**	**4 hours**
VLSI design process: Architectural design, logical design, physical design; Layout styles: Full-custom, Semi-custom approaches		
Module:2	**MOS Devices**	**6 hours**
MOS Transistor Theory: nMOS, pMOS Enhancement Transistor; MOSFET as a Switch; Threshold voltage; MOS Device Design Equations; Second order effects; MOS Transistor Circuit Model; Stick Diagram; Layout Design Rules		
Module:3	**Circuit Characterization and Performance Estimation**	**6 hours**
DC Characteristics of CMOS Inverter; Switching Characteristics of CMOS Inverter; Transistor Sizing; Analytical Delay model: Rise Time, Fall Time, Gate Delays; RC Delay Models; Logical Effort; Power Dissipation: Static, Dynamic, Short Circuit Power Dissipation		
Module:4	**Combinational Logic Circuits**	**6 hours**
Static CMOS Design, Complex Logic Gates; Ratioed Logic; Pass-Transistor Logic; Transmission gate Logic; Dynamic CMOS Logic Design: Dynamic Logic Design Considerations, Speed and Power Dissipation of Dynamic logic, Signal integrity issues		
Module:5	**Design of Arithmetic Circuits**	**6 hours**
Adders/subtractors; Array based multipliers; Tree based multipliers; Speed and Area trade-off; Pipelined Multiplier and Accumulator; FIR filter design		
Module:6	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

List of Challenging Experiments (Indicative)

1.	Binary Adder/subtractor circuit design using different approaches to trade-off delay and area.
2.	Design and implementation of Carry Save Array multiplier (unsigned/signed)
3.	Design and implementation of Wallace-tree multiplier
4.	Design and implementation of Dadda-tree multiplier
5.	Design and implementation of Multiplier and Accumulator
6.	Design and implementation of FIR filter
7.	CMOS inverter switching characteristics using SPICE
8.	CMOS switch level implementation of Complex Boolean functions
9.	CMOS switch level implementation of adder and subtractor
10.	Implementation of Boolean function using various design styles.

Text Books			
1.	Neil H.E.Weste, David Money Harris, “CMOS VLSI DESIGN: a circuits and systems perspective”, 4th edition, Pearson 2015		
2	Jan Rabaey, Anantha Chandrakasan, B.Nikolic, “Digital Integrated circuits: A design perspective”, 2nd Edition, Prentice Hall of India, 2016		
Reference Books			
1.	Samir Palnitkar, “Verilog HDL”, Prentice Hall, 2010		
2	Sung-Ma Kong, Yusuf Leblebici and Chulwoo Kim, "CMOS digital integrated circuits: analysis and design", 4th edition, McGraw-Hill Education, 2015		
Mode of Evaluation: CAT, Quiz, Assignments, FAT			
Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE212L	Engineering Optimization	2	1	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Provide a thorough knowledge of the most common optimization algorithms.
2. Formulate, dynamic programming and dynamic optimization problems and solve them.
3. Formulate and solve real-world optimization problems using nature-inspired algorithms.

Course Outcomes

On completion of this course, the students will be able to

1. Solve single and multi-variable optimization problems without and with constraints
2. Apply gradient and gradient-free optimization techniques for engineering applications
3. Utilize dynamic and convex programming tools for optimization problems
4. Develop optimal neural network training approaches
5. Apply natural inspired algorithms for engineering optimization

Module:1	Classical Optimization Basics	7 hours

Taylor's series; Single-variable optimization; Multivariable optimization without and with equality and inequality constraints; Lagrange multiplier method; Karush-Kuhn-Tucker conditions; Definiteness of matrices by eigen values; Quadratic forms; Sylvester's criterion; Convex programming problem, convex optimization

Module:2	One-Dimentional search methods	5 hours

Golden section search, Fibonacci search, bisection method, Newton's method; Inexact line search

Module:3	Gradient based optimization	7 hours

Gradient descent method, Method of steepest descent; Newton's Method; Levenberg-Marquardt algorithm; Merits and demerits of these methods

Module:4	Conjugate Direction Methods	7 hours

Conjugate directions and conjugate gradient method, Fletcher-Reeves formula; Global and local convergence; Convergence analysis of all algorithms; Convergence constant, rate of convergence

Module:5	Dynamic Optimization	6 hours

Dynamic programming. Dynamic optimization; Comparison with static optimization. Sample applications of gradient-based methods in engineering; Applications of dynamic programming, dynamic optimization, convex optimization

Module:6	Application of optimization methods to neural networks	5 hours

Neural networks: Capabilities and limitations of single perceptron, multilayer perceptron, Activation functions; Universal function approximation theorem; Training by gradient based and gradient free methods; Back propagation

Module:7	Gradient-free Optimization	6 hours

Limitations of gradient-based methods; Direct and indirect methods; Evolutionary Computation; Introduction to evolutionary methods; Swarm intelligence methods; Nature based optimization methods; Simulated annealing

Module:8	Contemporary Issues	2 hours
	Total Lecture hours:	**45 hours**

Text Book

1. Chong and Zak, "Introduction to Optimization", John Wiley & Sons, Inc., 4th edition, 2013

Reference Books

1.	Ganguly, “Engineering Optimization, A Modern Approach”, Universities Press, 2012			
2.	S S Rao, “Engineering Optimization, Theory and Practice”, John Wiley & Sons, Inc., 5th edition, 2019			
3.	Fletcher, “Practical Methods of Optimization”, John Wiley & Sons, Inc., 2nd edition, 2013			
4.	Jasbir Arora, “Introduction to Optimum Design”, Elsevier, 4th edition, 2016			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies		28.05.2022		
Approved by Academic Council		No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BEEE213L	Embedded Systems Design	3	0	0	3
Pre-requisite	BEEE309L, BEEE309P	Syllabus version			
		1.0			

Course Objectives

1. Understand the contemporary embedded systems and its design constraints
2. Acquire hardware and software skills required for the role of embedded system engineer
3. Build automated systems for real world problems using low cost embedded platforms

Course Outcomes

On completion of this course, the students will be able to

1. Identify application specific microcontrollers
2. Develop embedded software using commercial integrated development environments
3. Apply suitable communication protocols to interface sensors and actuators
4. Implement commercial tools to develop RTOS based applications
5. Build linux kernel for low cost embedded platforms

Module:1	**Embedded Systems**	**3 hours**
Embedded system components; Examples of embedded system; Attributes; Characteristics; Challenges; Typical embedded system software operations		
Module:2	**ARM Cortex-M Architecture**	**4 hours**
CPU core: Architecture, Registers; Memory; Operating modes; Instructions: Instruction formats, and addressing modes; Exceptions and Interrupts; Commercial ARM Cortex-M microcontrollers		
Module:3	**Embedded Software Development**	**8 hours**
Embedded C programming: Number systems, Data types, Data structures, Functions, Improving responsiveness; Interrupts; Finite State Machine; Embedded software development: Host and Target, Compiler, Assembler, Linker, and Loader; Hardware and Software debugging, In system programming		
Module:4	**Peripherals and Interfacing**	**8 hours**
GPIO; Timing generation and measurements: Timers, PWM; Control Applications; Analog interfacing and data acquisition: ADC, DAC, Measurement of voltage, current, and power; Analog comparator; DMA		
Module:5	**Serial Communication Protocols**	**7 hours**
Serial communication protocols: Synchronous Vs Asynchronous communication, UART, I2C: data frame, synchronization, I2C based accelerometer interfacing; SPI, and CAN: Architecture, electrical considerations, message formats, message types, transmission and arbitration; Data visualization using logic analysers		
Module:6	**Real Time Operating System**	**8 hours**
Survey of software architectures; Main memory management; Context switching; Process management and Scheduling; Shared data and semaphores; Interrupt routines in RTOS environment; Design example using open source RTOS		
Module:7	**Embedded Linux and Device Interfaces**	**5 hours**
Linux and Embedded system; Kernel modules; System configuration and boot process; Communication between kernel space and user space; Role of device driver; Classes of devices and modules; Char devices; System debugging and profiling; Application development: Using single board computers, IoT/ IIoT, Edge computing		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1	Alexander G Dean, “Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach”, ARM Education Media, 2021
2	Wim Vanderbauwhede and Jeremy Singer, “Operating Systems Foundations with Linux on the Raspberry Pi”, ARM Education Media, 2021
Reference Books	
1.	Yifeng Zhu, “Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C”, E-man Press LLC, 3rd Edition, 2018
2.	Jonathan W. Valvano, “Embedded Microcomputer Systems: Real Time Interfacing”, 3rd Edition, Cengage Learning, 2010
3	Raj Kamal, “Embedded Systems- Architecture, Programming and Design”, 3rd Edition, McGraw Hill Education India, 2017
4	James K Peckol, “Embedded Systems: A Contemporary Design Tool”, 2nd Edition, Wiley, 2019
Mode of Evaluation: CAT, Quiz, Assignment, FAT	

Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE310L	Digital Image Processing	3	0	0	3
Pre-requisite	BEEE302L, BEEE302P	Syllabus version			
		1.0			

Course Objectives

1. Understand digital image processing operations and algorithms
2. Explore the spatial and frequency domain techniques
3. Comprehend current trends and real time applications of digital image processing

Course Outcomes

On completion of this course, the students will be able to

1. Apply mathematical formulations for digital image processing
2. Classify spatial and frequency domain techniques
3. Evaluate the performance of image restoration and segmentation operations
4. Interpret compression and morphological techniques
5. Analyze color image processing and applications

Module:1	**Image Digitization and Enhancement in spatial domain**	**7 hours**

Elements of visual perception, Image sensing and acquisition, simple image formation, Image Sampling and Quantization; Relationship between pixels, Image modalities; Image enhancement: Gray level transformations, Histogram, Histogram equalization, Enhancement using arithmetic and logic operations; Smoothing spatial filters, Sharpening spatial filters

Module:2	**Image Transforms and Enhancement in frequency domain**	**8 hours**

Fourier transform, Discrete Fourier Transform, Fast Fourier Transform, Discrete Cosine Transform, Hadamard Transform, Discrete Wavelet Transform, Karhunen-Loeve Transform; Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering

Module:3	**Image Restoration**	**7 hours**

Image degradation model, Noise models; Types of Image Restoration techniques: Inverse filtering, Wiener filtering, Constraint Lease Square filtering, Performance Metrics in images

Module:4	**Image Segmentation**	**6 hours**

Thresholding, Point, Line and Edge detection, Segmentation by region growing and by region splitting and merging, Hough transform, Region segmentation using clustering, Watershed Transformation

Module:5	**Image Compression**	**7 hours**

Redundancy in images, Classification of Image Compression Schemes; Types of Coding: Run length Coding, Shannon-Fano coding, Huffman coding, Golomb coding, Arithmetic coding, Block Truncation Coding, Wavelet coding

Module:6	**Morphological operations**	**4hours**

Dilation and erosion, opening and closing, Hit-or- miss transforms; Representation: Boundary descriptors, Shape descriptors, Regional descriptors, Texture descriptors

Module:7	**Colour Image Processing**	**4 hours**

RGB, CMY and HSI Models, Gamma correction of Colour image, Chromaticity diagram, Colour Image Segmentation; Applications of Digital Image Processing: Machine Vision, Pattern Recognition, Video Processing

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1. R.C.Gonzalez, R.E.Wood , “Digital Image Processing”, Fourth Edition , Pearson Education, 2018
2. S.Jayaraman, S.Esakkirajan, T Veerakumar, “Digital Image Processing”, Tata

	McGraw Hill Education, 2nd Edition, 2020			
Reference Books				
1.	Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson Education, India, 2015			
2.	Scott E Umbaugh, "Digital Image Processing and Analysis: Human and Computer Vision Applications with CVIP tools", 3rd Edition, CRC Press, Taylor and Francis, 2018			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies		28.05.2022		
Approved by Academic Council		No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE31₁L	Design of Electrical Installations	3	0	0	3
Pre-requisite	BEEE207L, BEEE207P	Syllabus version			
		1.0			

Course Objectives

1. Familiarize the relevant concepts and parameters for design of electrical installations
2. Design and implement conductors, illumination system and earthing arrangement for installations
3. Evaluate the implementation of the various domestic and industrial installations

Course Outcomes

On completion of this course, the students will be able to:

1. Understand the generic concepts of design of electric installation with the relevant standards for implementation
2. Design the sizing of conductors and implement earthing systems for various electrical installations
3. Design and implement illumination system and layout arrangement for residential and industrial installations
4. Design and analyze various types distribution and substation systems
5. Estimate the implementation of various domestic and industrial installations

Module:1	Design Sequencing and Concepts for Installation	4 hours

General awareness of Indian and International Standards & Codes: IS 3043, IS 732, IS 2675, IS/ IEC 62305, IS 5216, IEC 60038, IEEE 998, IEEE 80; Load and supply characteristics, Outline of installations, Isolation and Switching, Fault protection, Fault rating of devices, Short circuit current protection, Overcurrent and overvoltage devices, cables, Protective conductors

Module:2	Sizing of Conductors, Busbars and Cables	4 hours

Types of Busbars, Ampacity calculation, Derating factors, Electromechanical considerations, Overload and short circuit requirements, Voltage drop, Correction for conductor operating temperature, Sizing of neutral

Module:3	Design Aspects for Earthing Systems	5 hours

Grounding principles, Types of earthing systems, Step and Touch potential -Tolerable step and touch potential, Role of Soil Resistivity in computing resistance, Grid resistance and grid spacing calculation

Module:4	Design of Illumination Systems	8 hours

Properties of good lighting scheme, Laws of illumination, Photometry, Types of lamps, Lighting calculations, Design of illumination schemes for residential, commercial, street lighting, factory lighting and flood lighting, LED lighting and energy efficient lamps

Module:5	Design of Substations	7 hours

Types of Substations, Types of Switching Schemes, Busbar Configurations, Electrical Clearances, Spatial separation, Maintenance zoning, Formulation of basic layout of substation, Substation equipment and generic design concepts (only major equipment), Cable Routing, Laying and Termination, Direct stroke lightning protection methods

Module:6	Design of Distribution System Installations	8 hours

Distribution system voltage levels, Types of distribution system configurations, One-line diagrams and generic layouts, Types of Poles, Class requirements, Lengths and clearance required for cross-arms, Pole depth, Pole pins, Pin spacing; Types of conductors for stringing: AAAC/ ASCR conductors, Choice & selection of insulators: Pin, Post and disc, hardware fixing arrangement with poles

Module:7	Estimation and Costing of Domestic and Industrial Installations	7 hours

Domestic Installations: Planning of circuits, Sub-circuits for different accessories, Electrical

layout, Estimation as per schedule rate pattern; Industrial Installations: Planning, designing and estimation of installations including motors of different ratings, Electrical circuit diagram, Preparation of list of materials, Service line connections; Estimate for Industrial loads; Over-head and Under-ground connections from pole to energy meter		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1.	"Electrical Installation Design Guide- Calculation for Electricians and Designers", 2018, 4th Edition, IET Press
2.	K.B Raina & S.K. Bhattacharya, "Electrical Design Estimating and Costing", 2018, 2nd Edition, New Age International Pvt. Limited
Reference Books	
1.	John D. McDonald, "Electric Power Substations Engineering", 2012, 3rd Edition, CRC Press
2.	T.A. Short, "Electric Power Distribution Equipment and Systems", 2006, 2nd Edition, CRC Press
3.	R.L. Giles, "Layout of EHV Substations", 1970, Cambridge University and IEE Press
4.	Indian and International Standards – Specifications of IS 732, IS- 3043, IS 5216, NEC-SP 30, NFPA 70, IEEE 998, IEEE 80

Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

BEEE391J	Technical Answers to Real Problems Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To gain an understanding of real-life issues faced by society.
2. To study appropriate technologies in order to find a solution to real life issues.
3. Students will design system components intended to solve a real-life issue.

Course Outcome:

1. Identify real life issue(s) faced by society.
2. Apply appropriate technologies to suggest a solution to the identified issue(s).
3. Design the related system components/processes intended to provide a solution to the identified issue(s).

Module Content

Students are expected to perform a survey and interact with society to find out the real life issues.

Logical steps with the application of appropriate technologies should be suggested to solve the identified issues.

Subsequently the student should design the related system components or processes which is intended to provide the solution to the identified real-life issues.

General Guidelines:

1. Identification of real-life problems
2. Field visits can be arranged by the faculty concerned
3. Maximum of 3 students can form a team (within the same/different discipline)
4. Minimum of eight hours on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified issue
6. Solution should be in the form of fabrication/coding/modelling/product design/process design/relevant scientific methodology(ies)
7. Consolidated report to be submitted for assessment
8. Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component
9. Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility
10. Contribution of each group member to be assessed

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No.65	Date	17-03-2022

BEEE392J	Design Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to upgrade a prototype to a design prototype.
2. Describe and demonstrate the techniques and skills necessary for the project.
3. Acquire knowledge and better understanding of design systems.

Course Outcome:

1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model.
2. Utilize the techniques, skills, and modern tools necessary for the project.
3. Synthesize knowledge and use insight and creativity to better understand and improve design systems.

Module Content

Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE393J	Laboratory Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. The student will be able to conduct experiments on the concepts already learnt.
2. Analyse experimental data.
3. Present the results with appropriate interpretation.

Course Outcome:

1. Design and conduct experiments in order to gain hands-on experience on the concepts already studied.
2. Analyse and interpret experimental data.
3. Write clear and concise technical reports and research articles

Module Content

Students are expected to perform experiments and gain hands-on experience on the theory courses they have already studied or registered in the ongoing semester. The theory course registered is not expected to have laboratory component and the student is expected to register with the same faculty who handled the theory course. This is mostly applicable to the elective courses. The nature of the laboratory experiments is depended on the course.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE394J	Product Development Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to translate a prototype to a useful product.
2. Apply relevant codes and standards during product development.
3. The student will be able to present his results by means of clear technical reports.

Course Outcome:

1. Demonstrate the ability to translate the developed prototype/working model to a viable product useful to society/industry.
2. Apply the appropriate codes/regulations/standards during product development.
3. Write clear and concise technical reports and research articles

Module Content

Students are expected to translate the developed prototypes / working models into a product which has application to society or industry.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No.65	Date	17-03-2022

BEEE395J	Computer Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to analyse complex engineering processes.
2. Describe the applications and limitations of a given engineering process.
3. Present the results in written reports and oral presentations.

Course Outcome:

1. Utilize programming skills/modelling to analyse complex engineering processes/problems.
2. Demonstrate the ability to evaluate the applicability and limitations of the given engineering process.
3. Communicate effectively through written reports, oral presentations, and discussion.

Module Content

Students are expected to use programming skills or modelling to analyse complex engineering processes. The student should be able to evaluate the application and limitations of the said engineering processes.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No.65	Date	17-03-2022

BEEE396J	Reading Course	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. The student will be able to analyse and interpret published literature for information pertaining to niche areas.
2. Scrutinize technical literature and arrive at conclusions.
3. Use insight and creativity for a better understanding of the domain of interest.

Course Outcome:

1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains.
2. Examine technical literature, resolve ambiguity, and develop conclusions.
3. Synthesize knowledge and use insight and creativity to better understand the domain of interest.

Module Content

This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No.65	Date	17-03-2022

BEEE397J	Special Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to identify and solve problems in a time-bound manner.
2. Describe major approaches and findings in the area of interest.
3. Present the results in a clear and concise manner.

Course Outcome:

1. To identify, formulate, and solve problems using appropriate information and approaches in a time-bound manner.
2. To demonstrate an understanding of major approaches, concepts, and current research findings in the area of interest.
3. Write clear and concise research articles for publication in conference proceedings/peer-reviewed journals.

Module Content

This is an open-ended course in which the student is expected to work on a time bound research project under the supervision of a faculty. The result may be a tangible output in terms of publication of research articles in a conference proceeding or in a peer-reviewed Scopus indexed journal.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE398J	Simulation Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to simulate a real system.
2. Identify the variables which affect the system.
3. Describe the performance of a real system.

Course Outcome:

1. Demonstrate the ability to simulate and critically analyse the working of a real system.
2. Identify and study the different variables which affect the system elaborately.
3. Evaluate the impact and performance of the real system.

Module Content

The student is expected to simulate and critically analyse the working of a real system. Role of different variables which affect the system has to be studied extensively such that the impact of each step in the process is understood, thereby the performance of each step of the engineering process is evaluated.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course code	Course Title	L	T	P	C
BEEE401E	Power Systems Protection and Switchgear	2	0	2	3
Pre-requisite	BEEE306L, BEEE306P	Syllabus version			
		1.0			

Course Objectives

1. Perceive neutral grounding and characteristics of protective relays
2. Emphasize and realize the protection schemes of Power System components
3. Impart the knowledge on the principle and operation of circuit breakers

Course Outcomes

On completion of the course the student will be able to

1. Realize grounding, relays characteristics and protection schemes
2. Identify appropriate protection schemes for different power system components
3. Apply the process and execution of circuit breakers
4. Selecting an appropriate type of circuit breaker based on voltage and current ratings in the system

Module:1	**Grounded Neutral System**	**4 hours**
Ungrounded and grounded neutral system; Types of neutral grounding; Earthing at substation and line structure		
Module:2	**Protective devices**	**5 hours**
Review of relay characteristics; Protection schemes: simple and percentage differential relay protection scheme, Distance protection scheme by simple impedance relay, mho relay and reactance relay; Protective transformers: Current transformer, Potential transformer, Characteristics		
Module:3	**Digital and Numerical Relay**	**5 hours**
Digital relay; Micro-Processor based relay; Trivector meter; Numerical Relay: Numerical relaying and algorithms; Phasor extraction; Smart relay; Smart meter		
Module:4	**Unit Protection Schemes**	**6 hours**
Generator: Stator protection, rotor protection, loss of excitation; Transformer protection from external faults, internal faults and incipient faults; Bus-bar differential protection; Transmission line protection using digital relays; Concepts of Digital protection		
Module:5	**Arc Phenomenon**	**4 hours**
Arc: Formation, Interruption, Extinction; Restriking voltage: Peak restriking voltage, Recovery voltage, rate of rise of recovery voltage, making & breaking capacity; Resistance switching: current chopping, interruption of capacitive current		
Module:6	**Circuit Breakers**	**4 hours**
DC Circuit breaking; Types of Circuit breakers: Oil, Air blast, Vacuum and SF6; Testing of circuit breakers; Type tests and Routine tests		
Module:7	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Indicative Experiments

1.	(i) Performance characteristics of current transformers (ii) Earth leakage protection using core balance transformers
2.	(i) Study of Zonal Protection Scheme (ii) Testing of breakdown voltage strength of the given sample of transformer oil using Transformer oil testing kit
3.	(i) Earth electrode resistance and soil resistivity measurements using Megger Earth Tester

	(ii) Cable fault location
4.	(i) Earth fault protection for a 3-ϕ induction motor using Air circuit breakers (ii) Microcontroller based over and under voltage, IDMT/DMT relay
5.	Transformer protection using differential protection scheme
6.	Transformer protection using over current relay
7.	Performance characteristics over current relay (IDMT Type)
8.	Protection of three phase induction motor against earth fault using IDMT type Earth Fault Over current relay
9.	Alternator Protection using (i) Reverse Power Relay (ii) Differential relay
10.	Time graded protection for Radial Feeders
11.	Fault analysis of 3- ϕ Alternator
12.	Generator protection using numeric protective relays, over current, over voltage and under voltage relay
	Total Laboratory Hours | **30 hours**

Text Books	
1.	Vladimir Gurevich, “Digital Protective Relays, Problems and Solutions”, 2019, CRC Press, Delhi
2.	Y.G.Paithankar and S.R.Bhide, “Fundamentals of Power System Protection”, 2014, 2nd Edition, PHI Learning Private Limited, Delhi
Reference Books	
1	J.B.Gupta, “A Course in Power Systems”, 2020, 11th Edition, S.K. Kataria & Sons, New Delhi
2.	C.L.Wadhwa, "Electrical Power Systems", 2017, 7th Edition, New Academic Science Limited, London
3.	B. Ravindranath, and N. Chander, “Power System Protection & Switchgear”, 2019, 2nd Edition, New Age International Private Limited, Chennai

Mode of Evaluation: CAT, Assignment, Quiz and FAT

Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BEEE401E	Power Systems Protection and Switchgear	2	0	2	3
Pre-requisite	BEEE306L, BEEE306P	Syllabus version			
		1.0			

Course Objectives

1. Perceive neutral grounding and characteristics of protective relays
2. Emphasize and realize the protection schemes of Power System components
3. Impart the knowledge on the principle and operation of circuit breakers

Course Outcomes

On completion of the course the student will be able to

1. Realize grounding, relays characteristics and protection schemes
2. Identify appropriate protection schemes for different power system components
3. Apply the process and execution of circuit breakers
4. Selecting an appropriate type of circuit breaker based on voltage and current ratings in the system

Module:1	**Grounded Neutral System**	**4 hours**
Ungrounded and grounded neutral system; Types of neutral grounding; Earthing at substation and line structure		
Module:2	**Protective devices**	**5 hours**
Review of relay characteristics; Protection schemes: simple and percentage differential relay protection scheme, Distance protection scheme by simple impedance relay, mho relay and reactance relay; Protective transformers: Current transformer, Potential transformer, Characteristics		
Module:3	**Digital and Numerical Relay**	**5 hours**
Digital relay; Micro-Processor based relay; Trivector meter; Numerical Relay: Numerical relaying and algorithms; Phasor extraction; Smart relay; Smart meter		
Module:4	**Unit Protection Schemes**	**6 hours**
Generator: Stator protection, rotor protection, loss of excitation; Transformer protection from external faults, internal faults and incipient faults; Bus-bar differential protection; Transmission line protection using digital relays; Concepts of Digital protection		
Module:5	**Arc Phenomenon**	**4 hours**
Arc: Formation, Interruption, Extinction; Restriking voltage: Peak restriking voltage, Recovery voltage, rate of rise of recovery voltage, making & breaking capacity; Resistance switching: current chopping, interruption of capacitive current		
Module:6	**Circuit Breakers**	**4 hours**
DC Circuit breaking; Types of Circuit breakers: Oil, Air blast, Vacuum and SF6; Testing of circuit breakers; Type tests and Routine tests		
Module:7	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Indicative Experiments

1.	(i) Performance characteristics of current transformers (ii) Earth leakage protection using core balance transformers
2.	(i) Study of Zonal Protection Scheme (ii) Testing of breakdown voltage strength of the given sample of transformer oil using Transformer oil testing kit
3.	(i) Earth electrode resistance and soil resistivity measurements using Megger Earth Tester

	(ii) Cable fault location
4.	(i) Earth fault protection for a 3-ϕ induction motor using Air circuit breakers (ii) Microcontroller based over and under voltage, IDMT/DMT relay
5.	Transformer protection using differential protection scheme
6.	Transformer protection using over current relay
7.	Performance characteristics over current relay (IDMT Type)
8.	Protection of three phase induction motor against earth fault using IDMT type Earth Fault Over current relay
9.	Alternator Protection using (i) Reverse Power Relay (ii) Differential relay
10.	Time graded protection for Radial Feeders
11.	Fault analysis of 3- ϕ Alternator
12.	Generator protection using numeric protective relays, over current, over voltage and under voltage relay
	Total Laboratory Hours | **30 hours**

Text Books	
1.	Vladimir Gurevich, “Digital Protective Relays, Problems and Solutions”, 2019, CRC Press, Delhi
2.	Y.G.Paithankar and S.R.Bhide, “Fundamentals of Power System Protection”, 2014, 2nd Edition, PHI Learning Private Limited, Delhi
Reference Books	
1	J.B.Gupta, “A Course in Power Systems”, 2020, 11th Edition, S.K. Kataria & Sons, New Delhi
2.	C.L.Wadhwa, "Electrical Power Systems", 2017, 7th Edition, New Academic Science Limited, London
3.	B. Ravindranath, and N. Chander, “Power System Protection & Switchgear”, 2019, 2nd Edition, New Age International Private Limited, Chennai

Mode of Evaluation: CAT, Assignment, Quiz and FAT

Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE402L	Power Systems Operation and Control	3	0	0	3
Pre-requisite	BEEE306L, BEEE306P	Syllabus version			
		1.0			

Course Objectives

1. Model and analyze the frequency control and voltage regulation on power system
2. Allocate the generator units economically and calculates the individual power generation
3. Introduces the recent developments in the energy management systems (EMS) and system security in modern power system network

Course Outcomes

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

1. Analyze the power system load characteristics
2. Model the power system for frequency control and voltage regulation and analyse for stability
3. Schedule the generation units and economically generate the required power
4. Identify the system state under abnormal condition and predicts the contingencies in the network
5. Realize the working of SCADA and Energy Management System in the control centre

Module:1	Power System Load Characteristics	5 hours

Power scenario in Indian grid; Indian Grid codes; Functions of National and regional load dispatch centres; Requirements of good power system, Necessity of voltage and frequency regulation; Automatic generation control; System load characteristics: Load curve and load duration curve, Load factor and diversity factor; Reserves; Case studies

Module:2	Real Power and Frequency Control	7 hours

Relation between real power and frequency, Turbine speed governing mechanisms and modelling; Load Frequency Control (LFC) of single area system: Static and dynamic responses of uncontrolled and controlled cases, Control area concept; Tie line modelling; LFC of two area system: Static and dynamic responses, tie line with frequency bias control, Integration of economic despatch control with LFC

Module:3	Reactive Power and Voltage Control	7 hours

Relation between reactive power and voltage control, Generation and absorption of reactive power, Basics of reactive power control, Automatic Voltage Regulator (AVR), Brushless AC excitation system and AVR modelling: Static and dynamic responses; Voltage drop in transmission line, Methods of reactive power control on transmission system: Concept of Tap changing transformer, Series and shunt Reactor, FACTS devices

Module:4	Unit Commitment	6 hours

Cost function formulation, Constraints in unit commitment: spinning reserve, thermal, hydro, must run, fuel and other constraints, unit commitment solution methods: Priority-list, dynamic programming

Module:5	Economic Dispatch	7 hours

Comparison of economic dispatch and unit commitment (UC), Incremental cost curve, co-ordination equations without loss and with loss, Economic dispatch with Linear Programming, Lambda iteration method, dynamic programming, Base point and participation factors

Module:6	System Security	5 hours

Factors affecting power system security, security state diagram; Contingency analysis: Generation and transmission outages; State estimation; Application of power systems state estimation

Module:7	Energy Management System	6 hours

Energy control centre, EMS functions, framework and time frame, data acquisition and

control: SCADA, RTU and IED, Monitor, WAMS, PMU with GPS		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Books		
1.	Allen J Wood, Bruce F Wollenberg, Gerald B Sheble, "Power Generation Operation and Control", 2014, 3rd Edition, John Wiley Publication	
Reference Books		
1.	Olle. I. Elgerd, "Electric Energy Systems Theory – An Introduction", 2nd Edition, 46th reprint, McGraw-Hill Education, 2017	
2.	John J. Grainger, William D. Stevenson, Gary W. Chang, "Power System Analysis", 2016, McGraw-Hill Education	
3.	Kundur, Prabha S, "Power System Stability and Control", 3rd edition, CRC Press, 2017	
Mode of Evaluation: CAT, Assignment, Quiz, FAT		

Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE403L	Restructured Power Systems	3	0	0	3
Pre-requisite	BEEE304L	Syllabus version			
		1.0			

Course Objectives

1. Explore the restructuring of power industry and market models
2. Investigate various key issues pertaining to deregulation both in the transmission and distribution system
3. Illustrate the various power sectors in India and abroad

Course Outcomes

On completion of the course the student will be able to

1. Comprehend the difference between the conventional & restructured power system operation.
2. Recognize the power market operations in various countries
3. Analyze the key issues in transmission and congestion pricing
4. Solve the unaddressed problems in electricity market

Module:1	**Power System Restructuring: An Overview**	**5 hours**

Structure of a deregulated electricity system; Comparison with vertically integrated electric utility; Motivation for restructuring of power system: Different entities, Benefits from a competitive environment; International scenario in deregulation: USA, UK, Canada, Norway and Sweden

Module:2	**Operations in Power Market**	**6 hours**

Restructuring Models: PoolCo, bilateral, hybrid models; Role of ISO; Power exchange; Market Clearing Price; Market operations: Day ahead and hour ahead market, Elastic and inelastic market, Market power

Module:3	**Market settlement**	**6 hours**

UK; Nordic electricity market; Single auction and double auction market bidding strategies; ISO in bilateral market; Analysis of bilateral market; GENCO in pool market; GENCO in bilateral market; Market participation issues

Module:4	**Transmission and Congestion Pricing**	**7 hours**

Transmission Pricing; Transmission cost allocation methods: Postage stamp rate method, contract path method, MW Mile method with examples; Congestion Pricing; Congestion pricing methods, Transmission rights

Module:5	**Congestion Management & ATC**	**7 hours**

Management of Inter-zonal and intra- zonal congestion: solution procedure, Formulation of Inter-zonal congestion sub problem with examples, Formulation of Intra-zonal congestion sub problem with examples; Definitions of ATC; OASIS; Methods of ATC Determination

Module:6	**Ancillary service Management**	**6 hours**

Types of Ancillary services as per NERC, Classification of Ancillary services: Load generation balancing related services, Voltage control and reactive power support devices, Black start capability service; NERC standards: CPS1 and CPS2, Ancillary service management various countries: USA, UK, Australia, Nordic countries

Module:7	**Reforms in Indian Power Sector**	**6 hours**

Framework of Indian power sector; Reform initiatives; Availability based tariff; Electricity act 2003; players in the Indian power system; Open access issues; Power exchange reforms in the near future

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1.	Shahidehpour, Mohammad, and Alomoush, M. "Restructured Electrical Power Systems: Operation: Trading, and Volatility", CRC Press, USA, 2017
2.	Kankar Bhattacharya, Math H.J. Bollen, Jaap E. Daalder, "Operation of Restructured Power Systems", Springer USA, 2012
Reference Books	
1.	Loi Lei Lai, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology", Wiley, USA, 2001
2.	Marija Illic,Francisco Galiana and Lester fink, "Power Systems Restructuring: Engineering and Economics", Kluwer Academic Publishers, USA, 2000
3.	Venkatesh, P., Manikandan, B. V., Srinivasan, A., Raja, S. C., "Electrical Power Systems: Analysis, Security and Deregulation", PHI Learning, India, 2012

Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE404L	High Voltage Engineering	3	0	0	3
Pre-requisite	BEEE304L	Syllabus version			
		1.0			

Course Objectives

1. Discuss and analyze the various breakdown mechanisms in gaseous, liquid and solid dielectrics
2. Design high voltage, high current and impulse generators
3. Analyze the various methodologies for high voltage, high current and impulse voltage measurement
4. Explain the various types of over-voltages in power system and methods for insulation coordination of power apparatus

Course Outcomes

On completion of the course, the student will be able to

1. Analyze the various types of electrical stress control techniques in gas and vacuum insulation systems
2. Derive and analyze the various mechanisms in gas, liquid and solid dielectrics breakdown
3. Design the high voltage direct current, alternating current and impulse generators
4. Analyze the various types of high voltage and high current measurement techniques
5. Evaluate the impact of various insulation tests of electrical power apparatus

Module:1	**High voltages in electrical systems and electric stress**:	6 Hours

Levels of High voltage, Electrical insulation and Dielectrics, importance of electric field intensity in the dielectrics, Electric field stresses, gas / vacuum as insulator, estimation and control of electric stress, Surge voltage their distribution and control

Module:2	**Conduction and breakdown in gases**	6 Hours

Gases as insulating media, Collision Processes, Ionization Processes, Townsend's current growth equation, Current growth in the presence of secondary processes, Townsend's criterion for breakdown, the experimental determination of coefficients α and γ, breakdown in electro negative gases, time lags for breakdown, streamer theory of breakdown in gases, Paschen' law, breakdown in non-uniform field and corona discharges

Module:3	**Conduction and breakdown in Liquid, solid dielectrics**	6 Hours

Liquids as insulator, conduction and breakdown in pure liquids, conduction and breakdown in commercial liquids, testing of insulating oils, breakdown in solid dielectrics, intrinsic, electromechanical and thermal breakdown in composite dielectrics

Module:4	**Generations of high voltages and currents**	6 Hours

Generations of high direct current and alternating voltages, generation of impulse voltages and currents, tripping and control of impulse generators; Resonant transformer and tesla coil- generation of switching surges

Module:5	**Measurement of high voltages and currents**	6 Hours

Measurement of high direct current voltages, Measurement of high ac and impulse voltages, Measurement of high current, direct, alternating and impulse, cathode ray oscillographs for impulse voltage and current measurements, measurement of dielectric constant and loss factor; Digital techniques in high voltage measurement, partial discharge measurement

Module:6	**High voltage testing of electrical apparatus**	7 Hours

Testing of insulators and bushings, Testing of isolators and circuit breakers, Testing of cables, Testing of transformers, Testing of surge arrestors, radio interference measurements

Module:7	**Over voltage and insulation coordination in electric power system:**	6 Hours

Natural causes for over voltages, lightning switching and temporary over voltage, Protection against over voltage, Bewley's lattice diagram, and principles of insulation coordination on

high voltage and extra high voltage power system, High voltage testing of electrical power apparatus as per International and Indian standards: IEC, ISO				
Module:8	**Contemporary Issues**			**2 Hours**
	Total Lecture hours:			**45 hours**
Text Books				
1.	M.S.Naidu and V. Kamaraju, "High Voltage Engineering", TMH Publications, 6th edition, 2020			
2.	C.L.Wadhwa, "High Voltage Engineering", New Age Internationals Pvt. Ltd, 6th edition, 2020			
Reference Books				
1.	E.Kuffel, W.S.Zaengl, "High Voltage Engineering: Fundamentals", Elsevier, 3rd edition, 2016			
2.	Ravindra Arora, Wolfgang, "High Voltage Insulation Engineering", New Age Internationals Pvt. Ltd.2nd edition, 2019			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies		28.05.2022		
Approved by Academic Council		No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE405L	Renewable Energy Systems	3	0	0	3
Pre-requisite	BEEE301L, BEEE304L	Syllabus version			
		1.0			

Course Objectives:

1. Impart in depth knowledge of various types of renewable energy sources
2. Design and develop micro-grids using different renewable energy sources
3. Understand the basic principles of operation of the various renewable energy systems

Course Outcomes:

On completion of the course, the student will be able to

1. Discuss the different types of renewable energy sources
2. Design and develop the solar energy and wind energy systems
3. Understand the principle of operation and types of tidal and wave energy systems
4. Describe the different types of geothermal energy and biomass energy
5. Identify and discuss the chemical energy sources

Module:1	Need for Renewable Energy Sources	4 hours

Energy sources on earth; Environmental problems due to fossil fuels; Role of renewable energy sources: types, advantages and disadvantages; Scenario of conventional and non-conventional energy sources

Module:2	Solar Energy and Applications	8 hours

Solar radiation; Solar radiation geometry and measurements; Collectors: principles, types, characteristics and efficiency; Solar energy storage; Applications: water heaters, air heaters, cooling, cooking, pumping, drying, tower concept and solar pond; Photovoltaic (PV) systems: principles of PV energy conversion, PV cell, module, array, I-V and P-V characteristics, types, efficiency; Maximum power point tracking; Applications: stand-alone and grid connected systems

Module:3	Wind Energy and Applications	7 hours

Energy from the wind; theory, types of wind turbines; Performance and efficiency of wind machines; Wind energy generation schemes; Maximum power point tracking; Applications: stand-alone and grid connected systems

Module:4	Tidal and Wave Energy	7 hours

Tidal energy: Energy from tides, working principles, operation methods of power generation, energy estimation; Wave energy: Energy from waves, Wave energy conversion devices; Design of Ocean Thermal Energy Conversion (OTEC) plant; Economics and Environmental impacts of OTEC

Module:5	Geothermal Energy	6 hours

Geothermal sources: Hydrothermal resources, Geo-pressured resources, Hot dry rock resources, Magma resources, Analysis of geothermal resources, Prime movers for geothermal energy conversion

Module:6	Bio-Energy	6 hours

Biomass conversion techniques: Biogas generation, classification and types of biogas plants; Energy from Industrial, municipal and agricultural wastes; Biomass gasifiers: types, gasification process, pyrolysis, thermochemical processes

Module:7	Chemical Energy	5 hours

Hydrogen energy: Hydrogen production, storage; Fuel cell: Principle of operation, types of fuel cells, construction, applications; Battery energy storage: Fundamentals, characteristics, types, applications

Module:8	Contemporary Issues	2 hours

	Total Lecture Hours	**45 hours**
Text Books		
1	Frank Kreith, Susan Krumdeick, Principles of Sustainable Energy Systems, CRC press, Taylor and Francis group, 2nd edition, 2014	
2.	Gilbert M Masters, "Renewable and efficient electric power systems", John Wiley & Sons, 2nd edition, 2013	
Reference Books		
1	John Twidell and Tony Weir, Renewable Energy Resources, Second edition, Taylor and Francis, 2006	
2	Kothari, Dwarkadas Pralhaddas, K. C. Singal, and Rakesh Ranjan "Renewable energy sources and emerging technologies", PHI Learning Pvt. Ltd., 2011	
3	Arthur Pecher and Jens Peter Kofoed, Handbook of Ocean Wave Energy, Springer Edition, 2017	
Mode of Evaluation: CAT, Assignment, Quiz, FAT		
Recommended by Board of Studies	28.05.2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BEEE406L	FACTS and HVDC	3	0	0	3
Pre-requisite	BEEE301L, BEEE304L	Syllabus version			
		1.0			

Course Objectives

1. Examine the concepts of real and reactive power control using flexible AC transmission systems
2. Identify suitable FACTS controllers for enhancing the transmission capacity of AC system
3. Analyze HVDC over HVAC transmission systems and propose augmentation plans for replacing AC systems with DC systems

Course Outcomes

On completion of this course, the students will be able to

1. Comprehend the concepts of FACTS and HVDC systems
2. Analyze the functional operation and characteristics of shunt and series FACTS devices
3. Investigate the working principles, operation, and control of UPFC and IPFC
4. Apply FACTS controllers for mitigating Sub-Synchronous Resonance
5. Design different Multi Terminal DC systems for existing ac transmission lines

Module:1	Concept of FACTS and HVDC	6 hours

Need for transmission interconnections; Control of power flow in AC transmission lines: Types, Definitions of FACTS controllers and benefits; HVDC transmission, Comparison between HVDC and HVAC systems

Module:2	Shunt connected FACTS devices	7 hours

Shunt compensation: Midpoint voltage regulation for line segmentation, End of line voltage support to prevent voltage instability, Improvement of transient stability; Methods of controllable VAR generations, working principles and characteristics of SVC, TCR, TSC, FC-TCR, TCR-TSC, STATCOM, Comparison between STATCOM and SVC

Module:3	Series connected FACTS devices	7 hours

Series compensation: Concept of series capacitive compensation, voltage stability, improvement of transient stability; Variable Impedance Type Series Compensators: Working principles and characteristics of GCSC, TSSC and TCSC; Switching Converter Type Series Compensators: Working principles and characteristics of SSSC

Module:4	Combined Controllers	6 hours

Unified Power Flow Controller: Operating principles, conventional transmission control capabilities; Interline Power Flow Controller: Operating principles and characteristics; Generalized and Multifunctional FACTS controllers

Module:5	Special Purpose FACTS Controllers	5 hours

Torsional Oscillations in power systems; Sub-Synchronous Resonance (SSR); Design and operation of NGH-SSR damping scheme and Thyristor-Controlled Braking Resistor (TCBR); Controller coordination

Module:6	HVDC Transmission	7 hours

CSI and VSI based HVDC systems, Components of HVDC, Principles of HVDC Control, Configuration of HVDC system, Recent trends in HVDC transmission, HVDC systems in India, Case study

Module:7	HVDC Links and Grounding	5 hours

Types of DC links: Mono polar, Homo polar, bipolar, back-to-back HVDC connections, Multi-terminal HVDC systems, Grounding and Ground Electrodes for HVDC Systems

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	**45 hours**
Text Books		
1.	Bjarne R. Andersen, Stig L. Nilsson , “Flexible AC Transmission Systems”, CIGREE Green books, Springer Publications, 2020	
2	K.R.Padiyar, “HVDC Power Transmission Systems”, New Academic Science , 2017	
Reference Books		
1.	R.Mohan Mathur, Rajiv.K.Varma, “Thyristor Based FACTS Controllers for Electrical Transmission Systems”, John Wiley and Sons, 2011	
2	Jos Arrillaga, Y. H. Liu, Neville R. Watson, “Flexible Power Transmission: The HVDC Options”, Wiley 2007	
3	S Kamakshaiah, V Kamaraju , “HVDC Transmission”, Tata McGraw Hill, 2017	
Mode of Evaluation: CAT, Assignment, Quiz, FAT		
Recommended by Board of Studies	28.05.2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BEEE407L	Power Quality	3	0	0	3
Pre-requisite	BEEE301L	Syllabus version			
		1.0			

Course Objectives

1. Classify power quality disturbances as per IEEE/IEC standards
2. Analyze unbalance and design a compensator
3. Analyze and mitigate harmonics using filters

Course Outcomes

On completion of the course the student will be able to

1. Differentiate various power quality disturbances as per international standards
2. Characterize and evaluate harmonics due to various loads
3. Apply various sensors, equipment for power quality analysis as per standards
4. Analyze and design compensators and filters for mitigation of harmonics
5. Utilize various software tools for power quality analysis and applications

Module:1	**Standards of Power Quality**	**4 hours**

Overloading; Concepts of transients; Short duration variations: Interruption, Sags and swells; Long duration variation: Sustained interruption, undervoltage, overvoltage, voltage imbalance, voltage fluctuation, power frequency variations; International standards of power quality: IEEE, IEC, ANSI, EN, UL; Computer Business Equipment Manufacturers Associations (CBEMA) curve and ITI curve

Module:2	**Voltage Sags and Interruptions**	**7 hours**

Sources of sags and interruptions; Estimating Voltage Sag Performance; Principles of protection; Solutions at the end-user level; Evaluating the economics of different ride-through alternatives; Motor starting sags; Utility system fault; Clearing issues

Module:3	**Overvoltages**	**6 hours**

Sources of overvoltage: Capacitor switching, lightning, ferro resonance; Mitigation of voltage swells: surge arresters, low pass filters, power conditioners; Lightning protection: shielding, line arresters; Protection of transformers and cables

Module:4	**Harmonics**	**6 hours**

Harmonic sources: Commercial and industrial loads, locating harmonic sources; Power system response characteristics; Effect of harmonics: Harmonic distortion, Calculation of voltage and current harmonic indices for different loads, Inter harmonics

Module:5	**Power Quality Monitoring and Survey**	**5 hours**

Monitoring considerations; Power quality measurement equipment; Assessment of power quality measurement data; Application of intelligent systems; Power quality monitoring standards

Module:6	**Power Quality Mitigation**	**8 hours**

Analysis of unbalance; Compensator design; Mitigation of harmonics: Passive filters, Active filters; DSTATCOM; Dynamic Voltage Restorer (DVR); Active front-end converter

Module:7	**Harmonic Analysis Tools and Case Study**	**7 hours**

Software tools for power quality analysis; Harmonic Calculation Software (HCS); PQ analyser; Case studies and reports on impact of renewables integration on power quality parameters in an electrical network

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, “Electrical Power System

	Quality", Tata Mcgraw-Hill, New Delhi, 2012			
2.	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques", John Wiley & Sons Ltd, 2015			
Reference Books				
1.	Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, "Instantaneous power theory and applications to power conditioning", John Wiley & Sons, 2017			
2.	Mohammad A.SMasoum, Ewald F.Fuchs,"Power Quality in Power Systems and Electrical Machines", Academic Press, Elsevier, 2015			
Mode of Evaluation: CAT, Assignment, Quiz and FAT				
Recommended by Board of Studies		28.05.2022		
Approved by Academic Council		No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE408L	Reliability Engineering	3	0	0	3
Pre-requisite	BMAT202L, BMAT202P	Syllabus version			
		1.0			

Course Objectives

1. Create awareness on principles & methods of reliability and safety engineering tools and techniques
2. Comprehend the importance of reliability and its relationship with quality and safety
3. Analyze the factors that influence a system's reliability

Course Outcomes

On the completion of this course the student will be able to:

1. Examine the system's reliability requirements and assign sub-systems to them.
2. Construct models to analyze and predict reliability performance using block diagrams
3. Evaluate a design's ability to achieve its reliability and safety goals
4. Recognize the various reliability test methodologies and choose the appropriate one for assessing, demonstrating, or increasing reliability
5. Analyze how manufacturing variability affects system reliability

Module: 1	Reliability Fundamentals	6 hours

Reliability, Availability, Maintainability, Safety (RAMS), Benefits of Reliability Engineering, Bathtub Curve, Interrelationship between RAMS and quality; Product Life Cycle: Phases and applicable RAMS activities; Reliability Engineer: Role and responsibilities; Ethics in reliability engineering

Module: 2	Probability and Statistics for Reliability	6 hours

Statistics and probability concepts: Probability distributions, Probability functions; Sampling plans: Statistics and Reliability Testing, Confidence intervals; Weibull Analysis

Module: 3	Reliability and Safety in Design	6 hours

Reliability Requirements: Allocation, Reliability Modelling, Life Estimation, Part and Assembly Reliability Considerations; Reliability Analysis Techniques: FMEA, Fault Tree Analysis, Worst Case Analysis, Durability Analysis

Module: 4	Reliability Testing	9 hours

Reliability Testing Strategies: Introduction, Design of Experiments, Combinatorial Testing, HALT, RGT, ALT, Fracas and Root Cause Analysis; Sample Size and Test Duration: Guidelines, Weibull distribution, Sample size calculation, Life data Analysis

Module: 5	RAMS – AERO & MEDICAL	6 hours

RAMS in Aerospace Domain: ARP 4761 and ARP 4754, System Safety Assessment Process; Introduction: DO-178, DO-254 and DO-160E Standards; Process FMEA, MSG 3 Analysis; RAMS Case Study on Aero Program
RAMS in Medical Domain: Medical Devices, Classification and Applicable Reliability and Risk Management Tasks, Standards: ISO 14971, ISO 13485; Post Market Surveillance (PMS) in Medical Devices; RAMS Case Study on Medical Devices

Module: 6	RAMS – AUTO & INDUSTRIALS	6 hours

RAMS in Auto Domain: DFR Process in Auto Domain, ISO 26262, Functional Safety, ITAF 16949 Standard, Warranty Data Management; RAMS Case Study on Auto Systems
RAMS in Industrial Domain: IEC 61508, Functional Safety Standard; RAMS Case Study on Industrial Systems

Module: 7	RAMS - Appliances, Office Automation Products, Consumer	4 hours

	Electronics	
RAMS in Appliances, Case Study: Office Automation Product and Consumer Electronics		
Module: 8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours	**45 hours**

Text Book

1.	C. Ebeling, "An Introduction to Reliability and Maintainability Engineering", 3rd edition, Waveland Press, Inc., 2019
2.	CRE Primer – The Reliability Engineer solution Text, Quality Council of Indiana, USA, 2018

Reference Books

1.	Roy Billinton and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", 2nd edition, 4th reprint, Springer India Publications, 2013
2.	O'Connor, Patrick, and Andre Kleyner, "Practical reliability engineering", 5th edition, John Wiley & Sons, 2015
3	Andrew K.S. Jardine, Albert H.C. Tsang, Maintenance, Replacement, and Reliability: Theory and Applications, Second Edition - CRC Press – Taylor & Francis, 2013

Mode of Evaluation: CAT, Quiz, Assignments, FAT

Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE409L	Robotics and Control	3	0	0	3
Pre-requisite	BEEE303L, BEEE303P	Syllabus version			
		1.0			

Course Objectives

1. Impart knowledge on the kinematics and dynamics of the manipulator
2. Develop a controller for tracking a desired trajectory and path planning by a robot
3. Design machine vision system in robotic motion control

Course Outcome

On completion of this course, the students will be able to

1. Understand the forward and inverse kinematic of robot manipulators
2. Develop the dynamics of the robotic manipulator using Euler Lagrangian approach
3. Demonstrate an ability to generate joint trajectories for motion planning
4. Implement the multivariable controller for setpoint tracking and disturbance rejection
5. Apply machine vision system in robotic motion control

Module:1	**Robots**	**3 hours**
Types of robots; Degrees of freedom; Robot configurations and concept of workspace, End effectors; Different types of grippers: vacuum and other methods of gripping; Pneumatic, hydraulic and electrical actuators; Specifications of industrial robots		
Module:2	**Kinematics of Robot Manipulator**	**8 hours**
Coordinate frames, Rotation matrix, Inverse transformations, Composite rotation matrix, Homogenous transformations; Robotic manipulator joint co-ordinate system; Euler Angle & Euler transformations, Roll Pitch Yaw (RPY) transformation, Axis/angle transformation, D-H representation & transformation matrices for standard configurations, Jacobian transformation in robotic manipulation		
Module:3	**Dynamics of Robot Manipulator**	**8 hours**
Lagrangian formulation; General expression for kinetic and potential energy of n-link manipulator; Newton-Euler equations of motion; Application of Lagrange–Euler dynamic modelling of robotic manipulators; Two link robotic dynamics with distributed mass		
Module:4	**Trajectory and Path Planning**	**7 hours**
Trajectory planning and avoidance of obstacles; Trajectory for point-to-point motion; Cubic polynomial trajectory, Quintic polynomial; LSPB (Linear segment with parabolic blend); Minimum time trajectory; Trajectories for paths Specified by via points		
Module:5	**Control design for Robotic system**	**7 hours**
Feedback and closed loop control of robotic systems; Trajectory control; Velocity control; Force control; Computed torque control; Linear and Nonlinear controller design of robot		
Module:6	**Robot machine vision and sensor**	**8 hours**
Sensors and sensor-based system in robotics; Machine vision system: Description, Sensing, Digitizing, Image Processing, Analysis and Application; Robotic assembly sensors; Intelligent sensors; Visual servo-control		
Module:7	**Application of Robotics**	**2 hours**
Applications of robotics in active perception; Medical robotics; Autonomous vehicles and other areas		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1.	John J. Craig, "Introduction to Robotics: Mechanics and Control", 4th Edition, Pearson International, 2022
2.	Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", 2nd edition, Wiley, 2020
Reference Books	
1.	M.P. Groover, et.al., "Industrial Robots: Technology, Programming and applications", McGraw Hill, 2nd Indian edition, 2017
2.	M O Tokhi, A K M Azad, "Flexible robot manipulator: modelling, simulation and control" 2nd
3.	Edition, 2017 Ashitava Ghosal, "Robotic fundamental Concept and Analysis", Oxford University Press 11th Impression, 2015

Mode of Evaluation: CAT, Assignment, Quiz, FAT.

Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE410L	Machine Learning	3	0	0	3
Pre-requisite	BMAT202L, BMAT202P	Syllabus version			
		1.0			

Course Objectives

1. Implement the concepts of Machine Learning in socio-economic problem statements
2. Explore supervised learning, unsupervised learning and their applications.
3. Relate the theoretical and practical aspects of Probabilistic Graphical Models.
4. Impart knowledge in advanced learning of ML Algorithms

Course Outcomes

On completion of this course, the students will be able to

1. Solve regression and classification problems
2. Apply the supervised/unsupervised algorithms to a real problem and report on the expected accuracy that can be achieved by applying the models
3. Evaluate dimensionality reduction problems using PCA and ICA
4. Propose solutions for sequential decision making problems using Reinforcement learning by formulating MDP
5. Implement the ML models and Algorithms for Engineering applications

Module:1	Overview of Machine Learning	7 hours

The Motivation & Applications of Machine Learning: Learning Associations, Classification, Regression; Supervised Learning; Unsupervised Learning; Reinforcement Learning; Gradient Descent: Batch Gradient Descent, Stochastic Gradient Descent; Data pre-processing; Under fitting and Overfitting issues

Module:2	Artificial Neural Networks	7 hours

Perceptron Learning Algorithm; Multi-layer Perceptron: Feed-forward Network, Feedback Network: Back propagation Algorithm; Recurrent Neural Network (RNN); Convolutional Neural Network(CNN)

Module:3	Supervised Learning Methods	6 Hours

Linear Models; Classification: Support Vector Machines, Decision Tree, Random Forest ; Regression: Linear and Logistic

Module:4	Unsupervised learning Methods	7 hours

Clustering: K-means, Hierarchical; Association; Dimension Reduction: Principal Components Analysis, Independent Components Analysis

Module:5	Probabilistic Graphical Models	8 hours

Graphical Models: Undirected Graphical Models, Markov Random Fields; Directed Graphical Models: Bayesian Networks; Conditional Independence properties: Hidden Markov Models, Conditional Random Fields(CRFs)

Module:6	Reinforcement Learning	8 hours

Elements of Reinforcement Learning, Model-Based Learning: Value Iteration, Policy Iteration; Temporal Difference Learning: Exploration Strategies; Rewards and Actions; Markov Decision Process (MDP); Generalization to Continuous States; Q-learning

Module:7	Contemporary Issues	2 hours
	Total Lecture hours:	45 hours

Text Books

1. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, 3rd edition, 2014
2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012
3. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997

Reference Books

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, Reprint, 2016
2. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and

	Hall, CRC Press, 2nd edition, 2014		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEEE411L	Artificial Intelligence	3	0	0	3
Pre-requisite	BMAT202L, BMAT202P	Syllabus version			
		1.0			

Course Objectives

1. Impart artificial intelligence principles, techniques and its history
2. Assess knowledge representation, problem solving, and learning methods in engineering problems
3. Develop intelligent systems by assembling solutions to concrete computational problems

Course Outcomes

On completion of this course, the students will be able to

1. Evaluate Artificial Intelligence methods and describe their foundations
2. Apply the principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning
3. Demonstrate the knowledge of reasoning and representation for solving real world problems
4. Analyze and illustrate search and planning algorithms in problem solving
5. Implement the AI models for Engineering applications

Module:1	Agents & Environment	6 hours

Benefits and risks in AI, AI technique; Agents: Structure, behavior, intelligence, rationality; Environment: Nature of environment, task environment, properties; Types of agents: Goal based agents, utility-based agents, learning agents

Module:2	Problem Solving	4 hours

Problem representation: Problem space, state space, problem reduction; Case study: Tic - Tac - Toe problem; Solving Approaches: Search algorithms, Heuristics (informed search), Evolutionary computation

Module:3	Search Techniques	8 hours

Problem solving agents; Searching for Solutions; Uninformed Search Strategies: Breadth first search, depth first search, depth limited search, bidirectional search; Informed search strategies: Greedy best-first search, A* search, AO* search; Memory bounded heuristic search; Optimization problems: Hill climbing search, simulated annealing search, local beam search

Module:4	Constraint Satisfaction Problems	6 hours

Constraint propagation; Backtracking search for CSP; Local search for CSP; Adversarial search and games: Optimal decisions and strategies, Monte-Carlo tree search; Minimax search procedure; Alpha-Beta pruning; Additional refinements; Iterative deepening

Module:5	Knowledge Engineering	8 hours

Knowledge base: Representations, mapping of domain knowledge, if-then rules, semantic networks, frames; Predicate logic: Representing instance, computable functions and predicates, resolution, natural deduction; Procedural and declarative knowledge; Logic programming; Forward and backward reasoning; Matching; Representing knowledge in uncertain domain

Module:6	Reasoning and Planning	6 hours

Reasoning Systems for Categories; Reasoning with default information; Probabilistic reasoning: Bayesian networks, hidden Markov models, Kalman filter; Planning: Components of planning system, goal stack planning, hierarchical planning

Module:7	Decision Making	5 hours

Simple decisions: Beliefs, Desires, Combining beliefs and desires under uncertainty, Utility functions, Decision networks; Complex decisions: Sequential decision problems, MDPs, Partially observable MDPs

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	**45 hours**
Text Books		
1.	Russell. S and Norvig. P, “Artificial Intelligence - A Modern Approach”, 4th edition, Pearson, 2022	
2.	Poole. D and Mackworth. A, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press, 2nd Edition, 2017	
Reference Books		
1.	Ric, E., Knight, K and Shankar, B., “Artificial Intelligence”, 3rd edition, Tata McGraw Hill, 2017	
2.	Luger, G.F., “Artificial Intelligence -Structures and Strategies for Complex Problem Solving”, 7th edition, Pearson, 2011	
Mode of Evaluation: CAT, Assignment, Quiz, FAT		
Recommended by Board of Studies	28.05.2022	
Approved by Academic Council	No. 66	Date 16-06-2022

BEIE301L	Biomedical Instrumentation	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand bio-signal characteristics and acquisition of bio-signals.
2. Design and develop diagnostic, therapeutic and clinical equipment.
3. Compare and analyze imaging concepts for medical applications.

Course Outcomes

1. Analyze the physiological signals by applying principles of mathematics.
2. Apply the knowledge to select appropriate diagnostic instruments and advanced techniques.
3. Design and develop therapeutic devices in medical practices.
4. Develop the instruments for clinical applications and analysis.
5. Design a product with all relevant standards and realistic constraints.

Module:1	**Bio Signals**	**7 hours**

Bio signals characteristics: frequency and amplitude ranges; Origin of bio potentials, cell resting potential, action potentials; Electrode-electrolyte interface, electrode-skin interface, half-cell potential, non-polarizable electrodes; Types of electrodes: surface, needle, micro electrodes; Electrodes for ECG, EMG, EEG.

Module:2	**Bio Signal Amplifiers and Recorders**	**6 hours**

Bio amplifiers: Instrumentation amplifier, isolation amplifier; Recording devices; Bio electric Safety; Codes and standards.

Module:3	**Diagnostic Equipment**	**8 hours**

Electrophysiology: Electrocardiography (ECG), Einthoven's triangle, ECG lead system; Electroencephalography (EEG), 10-20 electrode system; Electromyography (EMG); Electrooculography (EOG); Blood pressure monitors; Pulse Oximeter; Spirometer.

Module:4	**Therapeutic Equipment**	**7 hours**

Pacemakers; Defibrillator; Heart lung machine; Nerve and muscle stimulators; Dialyser; Surgical diathermy; Ventilator.

Module:5	**Clinical Instruments**	**7 hours**

Analysis of Blood: Measurement of pH, pO2, pCO2 gas analysers; Photometers; Hematology; Electrophoresis: Principles and applications; Blood cell counters; Bio sensors: Blood Glucose Sensors; GSR measurements

Module:6	**Medical imaging techniques**	**8 hours**

Basics of diagnostic Radiology: X-Ray Imaging; Computed Tomography (CT); Magnetic Resonance Imaging (MRI) System; Ultrasonic Imaging Systems; Thermal Imaging; Radiation therapy: Gamma Camera, PET, SPECT.

Module:7	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**

Text Books

1	John G Webster, Amit J Nimunkar, Medical instrumentation: application and design, 2020, 5th Edition, John Wiley & Sons
2	Khandpur, R.S., Handbook of biomedical instrumentation, 2014, 3rd Edition, McGraw-Hill Education

Reference Books

1.	Carr, J.J. and Brown, J.M., Introduction to biomedical equipment technology. 2001, 4th Edition, Pearson College Division.			
2.	Cromwell, L., Weibell, F.J., Pfeiffer, E.A. and Usselman, L.B., Biomedical instrumentation and measurements,1990, Englewood Cliffs, N. J., Prentice-Hall, Inc			
3.	Haidekker, M.A., Medical imaging technology, 2013, Springer			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies		19-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BEEE101N	Introduction to Engineering	L	T	P	C
		0	0	0	1
Pre-requisite	Nil	**Syllabus version**			
		1.0			

Course Objective:

- To make the student comfortable and get familiarized with the facilities available on campus
- To make the student aware of the exciting opportunities and usefulness of engineering to society
- To make the student understand the philosophy of engineering

Course Outcome:

- To know the infrastructure facilities available on campus
- To rationally utilize the facilities during their term for their professional growth
- To appreciate the engineering principles, involve in life-long learning and take up engineering practice as a service to society

General Guidelines

1. Student should observe and involve in the activities during the induction programme. Both general activities and those which are discipline-specific should be included here.
2. Student should get familiarized with the infrastructure facilities available on campus during the general induction, school induction programme and also from the institutional website.
3. Student should attend the lecture by industries, including those on career opportunities, organized by the School and probably involve in 'Do-it-yourself' projects or projects involving reverse-engineering.
4. Activities under 'Do-it-Yourself' will be detailed by the School.
5. Student should prepare a report on the activities and observations, as per the specified format, and submit the same in institutional LMS, VTOP for further evaluation

   General instruction on formatting: Document to be prepared with the titles given in the template; Arial type with font size of 12 to be used; photographs can be included in the document as per the requirement; 1.5 line spacing to be used.

Mode of Evaluation: Evaluation of the submitted report and interaction with the students

Recommended by Board of Studies	02.07.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BHUM101N	Ethics and Values	IL	IT	IP	IC
		10	10	10	2
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity.
2. To understand the negative health impacts of certain unhealthy behavior.
3. To appreciate the need and importance of physical, emotional health and social health.

Expected Course Outcomes:

1. Students will be able to:
2. Follow sound morals and ethical values scrupulously to prove as good citizens.
3. Understand various social problems and learn to act ethically.
4. Understand the concept of addiction and how it will affect the physical and mental health.
5. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects.
6. Identify the main typologies, characteristics, activities, actors and forms of cybercrime.

Module:1 | Being Good and Responsible

Gandhian values such as truth and non-violence - Comparative analysis on leaders of past and present - Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society.

Module:2 | Social Issues 1

Harassment - Types - Prevention of harassment, Violence and Terrorism.

Module:3 | Social Issues 2

Corruption: Ethical values, causes, impact, laws, prevention - Electoral malpractices;
White collar crimes - Tax evasions - Unfair trade practices.

Module:4 | Addiction and Health

Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention - Ill effects of smoking - Prevention of Suicides;
Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases.

Module:5 | Drug Abuse

Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention.

Module:6 | Personal and Professional Ethics

Dishonesty - Stealinq - Malpractices in Examinations - Plaqiarism.

Module:7 | Abuse of Technologies

Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networkinq websites.

Total Lecture Hours: | 60 hours

Text Books:

1.	R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2019, 2nd Revised Edition, Excel Books, New Delhi.
2.	Hartmann, N., "Moral Values", 2017, United Kingdom: Taylor & Francis.

Reference Books :

1.	Rachels, James & Stuart Rachels, "The Elements of Moral Philosophy", 9th edition, 2019, New York: McGraw-Hill Education.

2.	Blackburn, S. "Ethics: A Very Short Introduction", 2001, Oxford University Press.
3.	Dhaliwal, K.K, "Gandhian Philosophy of Ethics: A Study of Relationship between his Presuoooosition and Precepts", 2016, Writers Choice, New Delhi, India.
4	Ministry of Social Justice and Empowerment, "Magnitude of Substance Use in India", 2019, Government of India.
5.	Ministry of Home Affairs, "Accidental Deaths and Suicides in India", 2019, Government of India.
6.	Ministry of Home Affairs, "A Handbook for Adolescents/ Students on Cyber Safety", 2018, Government of India.
Mode of Evaluation: Poster making, Quiz and Term End - Quiz	
Recommended by Board of Studies	2?-10-2021
Aooroved bv Academic Council	No. 64 Date 16-12-2021

BSSC101N	Essence of Traditional Knowledge	IL IT IP IC
		0 0 0 2
Pre-requisite	**Nil**	**Syllabus version**
		1.0

Course Objectives:

1. To impart the knowledge on Indian tradition and Culture.
2. To enable the students to acquire the traditional knowledge in different sectors.
3. To analyze and understand the Science, Management and Indian Knowledge System.

Course Outcomes:

1. Familiarize the concept of Traditional Indian Culture and Knowledge.
2. Explore the Indian religion, philosophy and practices.
3. Analyze and understand the Indian Languages, Culture, Literature and Arts.
4. Gives a clear understanding on the Indian perspective of modern scientific world and basic principles of Yoga and holistic health care system of India.
5. Enable knowledqe on Leqal framework and traditional knowledqe.

Module:1 Introduction to Traditional Knowledge

Traditional knowledge: Definition, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge, characteristics, Traditional knowledge vis-a-vis Indigenous knowledge, Traditional knowledge Vs Western Knowledge.

Module:2 Culture and Civilization

Introduction to Culture and Civilization, Culture and Heritage, Characteristics features of Indian Culture, Importance of Culture, Cultural practices in Ancient India, Medieval India and Modern India.

Module:3 Languages and Literature

Indian Languages and Literature: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature and literatures of South India.

Module:4 Religion and Philosophy

Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Reliqious Reform Movements in Modern India (selected movements only).

Module:5 Fine Arts in India

Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama. Science and Technology in India, Development of science in ancient, medieval and modern India. Traditional Medicine - Herbal Healing - Yoga and Pranayama practices.

Module:6 Traditional Knowledge in different sectors

Traditional knowledge and engineering, Traditional medicine system, Traditional knowledge in agriculture, Dependence of Traditional Societies on food and healthcare needs; Importance of conservation and sustainable development of environment, Management of biodiversity and Protection of Traditional knowledqe.

Module:7 Legal framework and Traditional Knowledge

Introduction on Legal framework and Traditional Knowledge: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, The protection of traditional knowledqe bill, 2016.

Total Lecture Hours: 60 hours

Text Books:

1. Shikha Jain, Parul G Munjal And Somya Joshi,(2020) Traditional Knowledge Systems And Cultural Heritage, Aryan Books International, India.
2. Anindya Bhukta(2020), Legal Protection for Traditional Knowledge: Towards A New

	Law for Indigenous Intellectual Property, Emerald Publishing Limited, United Kingdom.
Reference Books :	
1.	Traditional Knowledge System in India, by Amit Jha, 2009.
2.	Basant Kumar Mohanta & Vipin Kumar Singh (2012), "Traditional Knowledge System & Technology in India", Pratibha Prakashan, India.
3.	S. Baliyan, Indian Art and Culture, Oxford University Press, India.
4	http://indiafacts.org/author/michel-danino/
5.	GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi,2016.
Mode of Evaluation: Quiz and Term End - Quiz	
Recommended by Board of Studies	16-11-2021
Approved by Academic Council	No. 64 | Date | 16-12-2021

BEEE399J	Summer Industrial Internship	L	T	P	C
		0	0	0	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.

Course Outcome:

1. Demonstrate professional and ethical responsibility.
2. Understand the impact of engineering solutions in a global, economic, environmental and societal context.
3. Develop the ability to engage in research and to involve in life-long learning.
4. Comprehend contemporary issues.

Module Content

Four weeks of work at industry site.
Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE497J	Project - I	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcome:

1. Demonstrate professional and ethical responsibility.
2. Evaluate evidence to determine and implement best practice.
3. Mentor and support peers to achieve excellence in practice of the discipline.
4. Work in multi-disciplinary teams and provide solutions to problems that arise in multi-disciplinary work.

Module Content

Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.

Can be individual work or a group project, with a maximum of 3 students.

In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.

Carried out inside or outside the university, in any relevant industry or research institution.

Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BEEE498J	Project – II / Internship	L	T	P	C
		0	0	0	5
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcome:

1. Formulate specific problem statements for well-defined real life problems with reasona-ble assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing.
5. Synthesize the results and arrive at scientific conclusions / products / solution.
6. Document the results in the form of technical report / presentation.

Module Content

1. Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Can be individual work or a group project, with a maximum of 3 students.
4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
5. Carried out inside or outside the university, in any relevant industry or research institution.
6. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022