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)

CBCS Curriculum

(2022-2023)

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 offer an education in electrical engineering that provides strong fundamental knowledge, skills for employability, cross-disciplinary research and creates leaders who provide technological solutions to societal and industry problems.

MISSION STATEMENT OF THE SCHOOL OF ELECTRICAL ENGINEERING

- Provide personalized experiential learning in industry sponsored labs to prepare students in electrical engineering with strong critical thinking and employability skills.
- Foster design thinking, creativity and cross-disciplinary research with highly qualified faculty to create innovators and entrepreneurs in the broad area of electrical engineering.
- Collaborate with national and international partners to provide innovative solutions to societal and industry challenges.

B. Tech Electrical and Electronics Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO-1: Graduates will excel in solving industry problems, succeed as engineering practitioners, innovators and entrepreneurs or pursue higher education in electrical engineering and related fields.

PEO-2: Graduates will function with social responsibility, team spirit and environmental awareness and develop products that are reliable, cost effective and safe.

PEO-3: Graduates will demonstrate strong soft skills, uphold ethical standards and professional codes of practice and continually adapt to technological advancements through lifelong learning.

B. Tech Electrical and Electronics Engineering

PROGRAMME OUTCOMES (POs)

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

2) 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.

3) 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.

4) 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.

5) 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.

6) 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.

7) 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.

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

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

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.

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.

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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO-1: Design electrical and electronic systems using extensive knowledge of science and engineering.

PSO-2: Analyze power electronic circuits and power systems considering technical, economic and environmental constraints.

PSO-3: Apply modern intelligent computational tools to the solution of electrical engineering problems and engage in lifelong learning to adapt to technological advancements.

CREDIT INFO		
S.no	**Category**	**Credit**
1	Foundation Core	49
2	Foundation Core - Non Graded	2
3	Discipline-linked Engineering Sciences	10
4	Discipline Core	53
5	Discipline Elective	15
6	Projects and Internship	9
7	Open Elective	15
8	Non-graded Core Requirement	11
Total Credits		162

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	BEEE102L	Basic Electrical and Electronics Engineering	Theory Only	1.0	3	0	0	3.0
6	BEEE102P	Basic Electrical and Electronics Engineering Lab	Lab Only	1.0	0	0	2	1.0
7	BENG101L	Technical English Communication	Theory Only	1.0	2	0	0	2.0
8	BENG101P	Technical English Communication Lab	Lab Only	1.0	0	0	2	1.0
9	BENG201P	Technical Report Writing	Lab Only	1.0	0	0	2	1.0
10	BFLE200L	Foreign Language	Theory Only	1.0	2	0	0	2.0
11	BHSM200L	HSM Elective	Theory Only	1.0	3	0	0	3.0
12	BMAT101L	Calculus	Theory Only	1.0	3	0	0	3.0
13	BMAT101P	Calculus Lab	Lab Only	1.0	0	0	2	1.0
14	BMAT102L	Differential Equations and Transforms	Theory Only	1.0	3	1	0	4.0
15	BMAT201L	Complex Variables and Linear Algebra	Theory Only	1.0	3	1	0	4.0
16	BMAT202L	Probability and Statistics	Theory Only	1.0	3	0	0	3.0
17	BMAT202P	Probability and Statistics Lab	Lab Only	1.0	0	0	2	1.0
18	BPHY101L	Engineering Physics	Theory Only	1.0	3	0	0	3.0
19	BPHY101P	Engineering Physics Lab	Lab Only	1.0	0	0	2	1.0
20	BSTS101P	Quantitative Skills Practice I	Soft Skill	1.0	0	0	3	1.5
21	BSTS102P	Quantitative Skills Practice II	Soft Skill	1.0	0	0	3	1.5
22	BSTS201P	Qualitative Skills Practice I	Soft Skill	1.0	0	0	3	1.5
23	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
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

Discipline Core								
sl.no	Course Code	Course Title	Course Type	Ver	L	T	P	C
1	BEEE204L	Signals and Systems	Theory Only	1.0	2	1	0	3.0
2	BEEE205L	Electronic Devices and Circuits	Theory Only	1.0	2	0	0	2.0
3	BEEE205P	Electronic Devices and Circuits Lab	Lab Only	1.0	0	0	2	1.0
4	BEEE206L	Digital Electronics	Theory Only	1.0	3	0	0	3.0
5	BEEE206P	Digital Electronics Lab	Lab Only	1.0	0	0	2	1.0
6	BEEE215L	DC Machines and Transformers	Theory Only	1.0	2	0	0	2.0
7	BEEE215P	DC Machines and Transformers Lab	Lab Only	1.0	0	0	2	1.0
8	BEEE208L	Analog Electronics	Theory Only	1.0	3	0	0	3.0
9	BEEE208P	Analog Electronics Lab	Lab Only	1.0	0	0	2	1.0
10	BEEE301L	Power Electronics	Theory Only	1.0	3	0	0	3.0
11	BEEE302L	Digital Signal Processing	Theory Only	1.0	3	0	0	3.0
12	BEEE302P	Digital Signal Processing Lab	Lab Only	1.0	0	0	2	1.0
13	BEEE303L	Control Systems	Theory Only	1.0	3	0	0	3.0
14	BEEE303P	Control Systems Lab	Lab Only	1.0	0	0	2	1.0
15	BEEE304L	Power Systems Engineering	Theory Only	1.0	3	1	0	4.0
16	BEEE305L	Measurements and Instrumentation	Theory Only	1.0	2	0	0	2.0
17	BEEE305P	Measurements and Instrumentation Lab	Lab Only	1.0	0	0	2	1.0
18	BEEE306L	Power Systems Analysis	Theory Only	1.0	3	0	0	3.0
19	BEEE306P	Power Systems Analysis Lab	Lab Only	1.0	0	0	2	1.0
20	BEEE307L	Electric Drives	Theory Only	1.0	3	0	0	3.0
21	BEEE307P	Power Electronics and Drives Lab	Lab Only	1.0	0	0	2	1.0
22	BEEE308L	Communication Systems	Theory Only	1.0	3	0	0	3.0
23	BEEE309L	Microprocessors and Microcontrollers	Theory Only	1.0	3	0	0	3.0
24	BEEE309P	Microprocessors and Microcontrollers Lab	Lab Only	1.0	0	0	2	1.0
25	BEEE312L	AC Machines	Theory Only	1.0	2	0	0	2.0
26	BEEE312P	AC Machines Lab	Lab Only	1.0	0	0	2	1.0

No	Course Code	Course Title	Course Type	Ver	L	T	P	C
1	BEEE410L	Machine Learning	Theory Only	1.0	3	0	0	3.0
2	BEEE411L	Artificial Intelligence	Theory Only	1.0	3	0	0	3.0
3	BEEE210L	Electrical Machine Design	Theory Only	1.0	2	1	0	3.0
4	BEEE211E	VLSI Design	Embedded Theory and Lab	1.0	2	0	2	3.0
5	BEEE212L	Engineering Optimization	Theory Only	1.0	2	1	0	3.0
6	BEEE213L	Embedded Systems Design	Theory Only	1.0	3	0	0	3.0
7	BEEE310L	Digital Image Processing	Theory Only	1.0	3	0	0	3.0
8	BEIE301L	Bio-Medical Instrumentation	Theory Only	1.0	3	0	0	3.0
9	BEEE311L	Design of Electrical Installations	Theory Only	1.0	3	0	0	3.0
10	BEEE401E	Power Systems Protection and Switchgear	Embedded Theory and Lab	1.0	2	0	2	3.0
11	BEEE402L	Power Systems Operation and Control	Theory Only	1.0	3	0	0	3.0
12	BEEE403L	Restructured Power Systems	Theory Only	1.0	3	0	0	3.0
13	BEEE404L	High Voltage Engineering	Theory Only	1.0	3	0	0	3.0
14	BEEE405L	Renewable Energy Systems	Theory Only	1.0	3	0	0	3.0
15	BEEE406L	FACTS and HVDC	Theory Only	1.0	3	0	0	3.0
16	BEEE407L	Power Quality	Theory Only	1.0	3	0	0	3.0
17	BEEE408L	Reliability Engineering	Theory Only	1.0	3	0	0	3.0
18	BEEE409L	Robotics and Control	Theory Only	1.0	3	0	0	3.0
19	BEEE415L	Smart Grid	Theory Only	1.0	3	0	0	3.0
20	BEEE416L	Electric Vehicles	Theory Only	1.0	3	0	0	3.0
21	BEEE391J	Technical Answers to Real Problems Project	Project	1.0	0	0	0	3.0
22	BEEE392J	Design Project	Project	1.0	0	0	0	3.0
23	BEEE393J	Laboratory Project	Project	1.0	0	0	0	3.0
24	BEEE394J	Product Development Project	Project	1.0	0	0	0	3.0
25	BEEE396J	Reading Course	Project	1.0	0	0	0	3.0
26	BEEE397J	Special Project	Project	1.0	0	0	0	3.0
27	BEEE398J	Simulation Project	Project	1.0	0	0	0	3.0
28	BECE320E	Embedded C Programming	Embedded Theory and Lab	1.0	2	0	2	3.0
29	BEEE417L	Advanced Microcontroller	Theory Only	1.0	3	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

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 higher learning

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 biology (hemoglobin, 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 coupling 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 l Contemporary topics	**2 hours**
Guest lectures from Industry and, Research and Development Organizations	
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 assignment, Quiz and FAT	
Recommended by Board of Studies	28.06.2021
Approved by Academic Council	No.63 l Date l 23.09.2021

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BCHY101L.1	3	2	-	-	-	2	2	-	1	1	-	1	-	-	-
BCHY101L.2	3	2	-	-	-	2	2	-	1	1	-	-	-	-	-
BCHY101L.3	2	1	-	-	-	1	1	-	1	1	-	-	-	-	-
BCHY101L.4	2	1	-	-	-	1	-	-	1	1	-	-	-	-	-
BCHY101L.5	3	2	-	-	-	2	2	-	2	2	-	-	-	-	-

BCHY101P	Engineering Chemistry Lab	L T P C
		0 0 2 1
Pre-requisite	NIL	Syllabus version
		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 geometries through the experiments.

Indicative Experiments

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 Generation
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-exchange process
10.	Computational Optimization of molecular Geometry using Avogadro software

Total Laboratory Hours 30 hours

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

Recommended by Board of Studies 28.06.2021

Approved by Academic Council No. 63 Date 23.09.2021

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BCHY101P.1	3	2	-	-	1	2	2	-	2	2	-	1	-	-	-
BCHY101P.2	3	3	-	-	1	2	1	-	2	2	-	1	-	-	-
BCHY101P.3	3	3	-	-	1	2	1	-	2	2	-	-	-	-	-

BCSE101E	Computer Programming: Python	ILITIPIC
		11Iol 4 I 3
Pre-requisite	NIL	Syllabus version
		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 through programming language 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 I Introduction to Problem Solving	**1 hour**
Problem Solving: Definition and Steps, Problem Analysis Chart, Developing an Algorithm, Flowchart and Pseudocode.	
Module:2 I Python Programming Fundamentals	**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 I Control Structures	**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 I Collections	**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 I Strings and Regular Expressions	**2 hours**
Strings: Comparison, Formatting, Slicing, Splitting, Stripping - Regular Expressions: Matching, Search and replace, Patterns.	
Module:6 I Functions and Files	**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 I Modules and Packages	**2 hours**
Built-in modules - User-Defined modules - Overview of Numpy and Pandas packages.	
Total Lecture hours: I	**15 hours**

Text Book(s)

1.	Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 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 understanding 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	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BCSE101E.1	3	2	-	-	3	-	-	-	2	1	-	2			
BCSE101E.2	3	2	-	-	3	-	-	-	2	2	-	2			

BCSE103E	Computer Programming : Java	L T P C
		1 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 using 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-11th Edition, Pearson publisher, 2017.

Reference Books

1.	Herbert Schildt , The Complete Reference -Java, Tata McGraw-Hill publisher, 10th Edition, 2017.
2	Cay Horstmann,"Big 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 looping, arrays and strings.
3.	Demonstrate basic Object-Oriented programming elements.
4.	Experiment the use of inheritance, polymorphism and abstract classes.
5.	Designing packages and demonstrate exception handling.
6.	Demonstrate the use of 10 streams, file handling and serialization.
7.	Program 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	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BCSE103E.1	3	2	-	-	3	-	-	-	2	1	-	2			
BCSE103E.2	3	2	-	-	3	-	-	-	2	2	-	2			

Course code	Course Name	L	T	P	C
BEEE102L	Basic Electrical and Electronics Engineering	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		v. 1.0			

Course Objectives

1. Familiarize with various laws and theorems to solve electric and electronic circuits
2. Provide an overview on working principle of machines
3. Excel the concepts of semiconductor devices, op-amps and digital circuits

Course Outcomes

On completion of the course, the students will be able to:
1. Apply various electric circuit laws and theorems for electric circuit analysis
2. Determine the parameters of magnetic circuits
3.Explain the construction, working principle and applications of various types of electrical machines.
4. Design basic combinational circuits in digital system.
5. Illustrate the characteristics and applications of semiconductor devices.

Module:1	**DC Circuits**	**7 hours**
Basic circuit elements and sources; Ohms law; Kirchhoff's laws; Series and Parallel connection of circuit elements; Star-delta transformation; Mesh current analysis; Node voltage analysis; Theorems: Thevenin's, Maximum power transfer and Superposition theorem		
Module:2	**AC Circuits**	**8 hours**
Alternating voltages and currents, RMS, average, maximum values, Single Phase RL, RC, RLC series circuits, Power in AC circuits, Power Factor, Three phase balanced systems, Star and delta Connections, Electrical Safety, Fuses and Earthing		
Module:3	**Magnetic Circuits**	**7 hours**
Magnetic field; Toroidal core: Flux density, Flux linkage; Magnetic circuit with airgap; Reluctance in series and parallel circuits; Self and mutual inductance; Transformer: turn ratio determination		
Module:4	**Electrical Machines**	**7 hours**
Construction, working principle and applications of DC Machines, Transformers, Three phase Induction motors, synchronous generators, single phase induction motors, special machines stepper motor, universal motor and BLDC motor		
Module:5	**Digital Systems**	**7 hours**
Binary arithmetic; Number base conversion; Boolean algebra: simplification of Boolean functions using K-maps; Logic gates; Design of basic combinational circuits: adders, multiplexers, de-multiplexers		
Module:6	**Semiconductor Devices and Applications**	**7 hours**
Characteristics: PN junction diode, Zener diode, BJT, MOSFET; Applications: Rectifier, Voltage regulator, Operational amplifier		
Module:7	**Contemporary Issues**	**2 hours**
Guest lecture from Industry and R & D Organisations		
	Total Lecture hours:	**45 hours**

Text Books

1	Allan R. Hambley, "Electrical Engineering -Principles & Applications", 2019, 6th Edition, Pearson Education
2	V. D. Toro, Electrical Engineering Fundamentals, 2nd edition. PHI, 2014

Reference Books

1	R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th edition.

	Pearson, 2012			
2	DP Kothari & Nagrath, “Basic Electric Engineering”, 2019, Tata McGraw Hill			
Recommended by Board of Studies		28-05-2022		
Approved by Academic Council		No. 67	Date	08-08-2022

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE102L .1	3	2	1	1	1			2	2	1		1			
BEEE102L .2	3	2	1	1				2	2	1		1			
BEEE102L .3	2	1													
BEEE102L .4	3	2	1	1	1			2	2	1		1			
BEEE102L .5	2	1			1										

Course code	Basic Electrical and Electronics Engineering Lab	L	T	P	C
BEEE102P		0	0	2	1
Pre-requisite	Nil	Syllabus version			
		v. 1.0			

Course Objective

1. Design and solve the fundamental electrical and electronics circuits

Course Outcomes

1. Identify appropriate method of solving the fundamental electrical and electronics circuits.
2. Design and conduct experiments on electrical and electronics circuits.

Experiments (Indicative)	
1	Verification of Kirchoff's law
2	Verification of Maximum Power Transfer Theorem
3	Staircase wiring circuit layout for multi storage building
4	Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars.
5	Measurement of Earth resistance using Megger
6	Sinusoidal steady state response of RLC circuits
7	Three phase power measurement for ac loads
8	Design of half-adder and full-adder digital circuits
9	Synthesis of 8x1 multiplexer and 1x8 de-multiplexers
10	Characteristics of PN diode and acts as switch
11	Realization of single-phase rectifier
12	Design of regulated power supply using Zener diode.
13	Characteristics of MOSFET
14	Characteristics of BJT
15	Measurement of energy using single-phase energy meter
16	Measurement of power in a 1-phase circuit by using CTs and PTs

Total Laboratory Hours	**30** hours
Mode of assessment: Continuous assessment, FAT	

Recommended by Board of Studies	28-05-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE102P .1	3	2	1	1	1			2	2	2		1			
BEEE102P .2	3	2	1	1				2	2	2		1			

BENG101L	Technical English Communication	ILITIPIC
		2 0 0 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 Management	
Module:7 Research Writing	**4 hours**
Interpreting and Analysing a research article - Approaches to Review Paper Writing - Structure of a research article - Referencing	
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 Engineers.* 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: Cambridge University Press.			
Mode of Evaluation: CAT/ *Assignment* /Quiz/ FAT/ Group Discussion			
Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BENG101L.1	-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
BENG101L.2	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
BENG101L .3	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
BENG101L .4	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-

BENG101P	Technical English Communication Lab	ILITIPIC
		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 meaningful communication skills in writing and public speaking

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 I 28.06.2021

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BENG101P.1	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
BENG101P.2	-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
BENG101P.3	-	-	-	-	-	-	-	-	2	3	-	3	-	-	-

BENG102P	Technical Report Writing	L	T	P	C
		0	0	2	1
Pre-requisite	Technical English Communication	Syllabus version			
		V 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 ProofReading
   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 – Abstract Summary- 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 the Board of Studies: 28.06.2021

Approved by Academic Council	No. 63	Date : 23.09.2021

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BENG102P.1	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
BENG102P.2	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
BENG102P.3	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-

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-Lagranqe'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 integrals using them.

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

Guest lectures from Industry and, Research and Development organizations

	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 Kreyszig, Advanced Engineering 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, Assignment, Quiz and FAT	
Recommended by Board of Studies | 24.06.2021	
Approved by Academic Council | No. 63 | Date | 23.09.2021	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BMAT101L .1	3	1	-	-	-	-	-	-	1	1	-	2	-	-	-
BMAT101L .2	3	1	-	-	-	-	-	-	1	1	-	2	-	-	-
BMAT101L .3	3	2	-	-	-	-	-	-	1	1	-	2	-	-	-
BMAT101L .4	3	2	-	-	-	-	-	-	-	1	-	2	-	-	-
BMAT101L .5	3	2	-	-	-	-	-	-	-	1	-	2	-	-	-

BMAT101P	Calculus Lab	ILITIPIC
		Io Io I 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

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BMAT101P.1	3	2	-	-	2	-	-	-	1	2	-	2	-	-	-
BMAT101P.2	3	2	-	-	2	-	-	-	1	2	-	2	-	-	-

BMAT102L	Differential Equations and Transforms	IL IT IP IC
		3 1 0 4
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 Equations (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 using 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BMAT102L .1	3	1	-	-	-	-	-	-	-	1	-	1	-	-	-
BMAT102L .2	3	2	-	-	-	-	-	-	-	1	-	1	-	-	-
BMAT102L .3	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
BMAT102L .4	3	2	-	-	-	-	-	-	-	1	-	1	-	-	-
BMAT102L .5	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-

BMAT201L	Complex Variables and Linear Algebra	IL	IT	IP	IC
		3	11	10	14
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: **Total Tutorial hours** :	**45 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, 2nd 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BMAT201L .1	3	3	-	-	-	-	-	-	-	1	-	3	-	-	-
BMAT201L .2	3	3	-	-	-	-	-	-	-	1	-	3	-	-	-
BMAT201L .3	3	3	-	-	-	-	-	-	-	1	-	3	-	-	-
BMAT201L .4	3	3	-	-	-	-	-	-	-	1	-	3	-	-	-
BMAT201L .5	3	3	-	-	-	-	-	-	-	1	-	3	-	-	-

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BMAT202L .1	2	1	-	-	-	-	-	-	1	2	-	2	-	-	-
BMAT202L .2	3	2	-	-	-	-	-	-	1	2	-	2	-	-	-
BMAT202L .3	3	3	-	-	-	-	-	-	1	2	-	2	-	-	-
BMAT202L .4	3	3	-	-	-	-	-	-	1	2	-	2	-	-	-
BMAT202L .5	3	3	-	-	-	-	-	-	1	2	-	2	-	-	-

BMAT202P	Probability and Statistics Lab	L IT IP IC
		0 0 2 1
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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BMAT202P.1	3	3	-	-	2	-	-	-	1	2	-	3	-	-	-
BMAT202P.2	3	3	-	-	2	-	-	-	1	2	-	3	-	-	-

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 eigen frequencies.

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 CO_2 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BPHY101L .1	3	2	-	-	-	-	-	-	2	2	-	1	-	-	-
BPHY101L .2	2	1	-	-	-	-	-	-	1	1	-	-	-	-	-
BPHY101L .3	3	2	-	-	-	-	-	-	1	1	-	1	-	-	-
BPHY101L .4	3	2	-	-	-	-	-	-	2	2	-	1	-	-	-
BPHY101L .5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-

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 wavelengths) using diffraction grating
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 Schrodinger equation (e.g., particle in a box problem can be given as an assignment)
7.	To determine the refractive index of a prism using spectrometer (angle of prism will be given)
8.	To determine the efficiency of a solar cell
9.	To determine the acceptance angle and numerical aperture of an optical fiber
10.	To demonstrate the phase velocity and group 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BPHY101P .1	3	3	-	-	1	-	-	-	2	2	-	1	-	-	-
BPHY101P.2	3	2	-	-	1	-	-	-	2	1	-	-	-	-	-
BPHY101P.3	3	2	-	-	1	-	-	-	2	1	-	1	-	-	-

BSTS101P	Quantitative Skills Practice I	IL IT Ip IC To Io I3 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 allegations

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
- interrogative

Module:7	Reading Comprehension for Placement	3 hours

Types of questions - Comprehension strategies - Practice exercises

Module:8	Vocabulary for Placement	6 hours

Exposure to questions related to Synonyms -Antonyms -Analogy - Confusing words - Spelling 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 Publishing.

3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,* 1st (Ed.) Bangalore: 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	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BSTS101P.1	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-
BSTS101P.2	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-
BSTS101P.3	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-

BSTS102P	Quantitative Skills Practice II	L	T	P	C
		0	0	3	1.5
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives:

1. Help to trigger the students' logical thinking skills and apply it in real-life scenarios
2. Learn to deploy the strategies of solving quantitative ability problems
3. To expand the verbal ability of students
4. Assist to run the gamut of employability skills

Course Outcomes:

1. Become proficient in interacting and using decision making models effectively
2. Help to understand the given concepts expressly to deliver an impactful presentation
3. Acquire knowledge of solving quantitative aptitude and verbal ability questions effortlessly

Module:1	**Logical Reasoning puzzles - Advanced**	**2 hours**

Advanced puzzles:

- Sudoku
- Mind-bender style word statement puzzles
- Anagrams
- Rebus puzzles

Module:2	**Logical connectives, Syllogism and Venn diagrams**	**2 hours**

Logical Connectives - Advanced Syllogisms - 4, 5, 6 and other multiple statement problems - Challenging Venn Diagram questions: Set theory

Module:3	**Permutation, Combination and Probability - Advanced**	**4 hours**

Fundamental Counting Principle- Permutation and Combination - Computation of Permutation - Advanced problems - Circular Permutations - Computation of Combination - Advanced problems -Advanced probability

Module:4	**Quantitative Aptitude**	**6 hours**

Logarithms, Progressions, Geometry and Quadratic equations - Advanced

- Logarithm
- Arithmetic Progression
- Geometric Progression
- Geometry
- Mensuration
- Coded inequalities
- Quadratic Equations

Concepts followed by advanced questions of CAT level

Module:5	**Image interpretation**	**2 hours**

Image interpretation: Methods Exposure to image interpretation questions through brainstorming and practice

Module:6	**Critical Reasoning - Advanced**	**3 hours**

Concepts of Critical Reasoning - Exposure to advanced questions of GMAT level

Module:7	**Recruitment Essentials**	**8 hours**

Mock interviews

Cracking other kinds of interviews

Skype/ Telephonic interviews Panel interviews Stress interviews **Guesstimation** 1. Best methods to approach Guesstimation questions 2. Practice with impromptu interview on Guesstimation questions **Case studies/ situational interview** 1. Scientific strategies to answer case study and situational interview questions 2. Best ways to present cases 3. Practice on presenting cases and answering situational interviews asked in recruitment rounds		
Module:8	**Problem solving and Algorithmic skills**	**18 hours**
Logical methods to solve problem statements in Programming - Basic algorithms introduced		
	Total Lecture hours:	**45 hours**

Text Book(s)

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 Publishing.
3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt.Ltd.

Reference Books

1.	Sharma Arun. (2016). *Quantitative Aptitude*, 7th(Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BSTS102P.1	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-
BSTS102P.2	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-
BSTS102P.3	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-

Course Code	Course Title	L	T	P	C
BSTS201P	Qualitative Skills Practice - I	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To enhance the logical reasoning skills of students and improve problem-solving abilities
2. To strengthen the ability of solving quantitative aptitude problems
3. To enrich the verbal ability of the students for academic purposes

Course Outcomes:

1. Become experts in solving problems of quantitative Aptitude
2. Learn to defend and critique concepts of logical reasoning
3. Integrate and display verbal ability effectively

Module:1	Lessons on excellence	2 hours

Skill introspection - Skill acquisition - consistent practice

Module:2	Thinking Skill	6 hours

- Problem Solving
- Critical Thinking
- Lateral Thinking

Rebus puzzles, and word-link builder questions

Module:3	Logical Reasoning	6 hours

- Coding and Decoding
- Series
- Analogy
- Odd Man Out
- Visual Reasoning

Module:4	Sudoku puzzles	3 hours

Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers

Module:5	Attention to detail	3 hours

Picture and word driven Qs to develop attention to detail as a skill

Module:6	Quantitative Aptitude	14 hours

Speed Maths

- Addition and Subtraction of bigger numbers
- Square and square roots
- Cubes and cube roots
- Vedic maths techniques
- Multiplication Shortcuts
- Multiplication of 3 and higher digit numbers
- Simplifications
- Comparing fractions
- Shortcuts to find HCF and LCM
- Divisibility tests shortcuts

Algebra and functions		
Module:7	**Verbal Ability**	**6 hours**
Grammar challenge A practice paper with sentence based and passage-based questions on grammar discussed - Nouns and Pronouns, Verbs, Subject-Verb Agreement, Pronoun-Antecedent Agreement, Punctuations **Verbal reasoning**		
Module:8	**Recruitment Essentials**	**5 hours**
Looking at an engineering career through the prism of an effective resume • Importance of a resume - the footprint of a person's career achievements • Designing an effective resume • An effective resume vs. a poor resume • Skills you must build starting today the requisite? • How does one build skills **Impression Management** Getting it right for the interview: • Grooming, dressing • Body Language and other non-verbal signs • Displaying the right behaviour		

	Total Lecture hours:	**45 hours**

Text Book(s)	
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 Publishing.
3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt.Ltd.
Reference Books	
1.	Sharma Arun. (2016). *Quantitative Aptitude*, 7th(Ed.). Noida: McGraw Hill Education Pvt. Ltd.
Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)	

Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BSTS201P.1	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-
BSTS201P.2	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-
BSTS201P.3	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-

Course Code	Course Title	L	T	P	C
BSTS202P	Qualitative Skills Practice - II	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To apply critical thinking skills to related to their subject matter
2. To demonstrate competency in verbal, quantitative and reasoning aptitude
3. To produce good written skills for effective communication

Course Outcomes:

1. Apply critical thinking skills to problems solving related to their subject matter
2. Demonstrate competency in verbal, quantitative and reasoning aptitude
3. Display good written skills for use in academic and professional scenarios

Module:1	Logical Reasoning	5 hours

- Clocks
- Calendars
- Direction Sense
- Cubes

Practice on advanced problems

Module:2	Data interpretation and Data sufficiency - Advanced	5 hours

- Advanced Data Interpretation and Data Sufficiency questions of CAT level
- Multiple chart problems
- Caselet problems

Module:3	Time and work– Advanced	5 hours

- Work with different efficiencies
- Pipes and cisterns: Multiple pipe problems
- Work equivalence
- Division of wages
- Advanced application problems with complexity in calculating total work

Module:4	Time, Speed and Distance - Advanced	5 hours

- Relative speed
- Advanced Problems based on trains
- Advanced Problems based on boats and streams
- Advanced Problems based on races

Module:5	Profit and loss, Partnerships and averages - Advanced	5 hours

- Partnership
- Averages
- Weighted average
- Advanced problems discussed

Module:6	Number system - Advanced	4 hours

Advanced application problems on Numbers involving HCF, LCM, divisibility tests, remainder and power cycles.

Module:7	**Verbal Ability**	**13hours**

Sentence Correction - Advanced

- Subject-Verb Agreement
- Modifiers
- Parallelism
- Pronoun-Antecedent Agreement
- Verb Time Sequences
- Comparisons
- Prepositions
- Determiners

Quick introduction to 8 types of errors followed by exposure to GMAT level questions

Sentence Completion and Para-jumbles - Advanced

- Pro-active thinking
- Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues)
- Fixed jumbles
- Anchored jumbles

Practice on advanced GRE/ GMAT level questions

Reading Comprehension – Advanced

Exposure to RCs of the level of GRE/ GMAT relating to a wide variety of subjects

Module:8	**Writing skills for Placement**	**3 hours**

Essay writing

- Idea generation for topics
- Best practices
- Practice and feedback

	Total Lecture hours:	**45 hours**

Text Book(s)

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 Publishing.
3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt. Ltd.

Reference Books

1.	Sharma Arun. (2016). *Quantitative Aptitude*, 7th(Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)			
Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BSTS202P.1	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-
BSTS202P.2	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-
BSTS202P.3	1	-	-	-	-	-	-	-	2	3	-	2	-	-	-

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. Explain the fundamental physics of electronic materials.
2. Classify various types of current carrying mechanisms in semiconductor materials.
3. Illustrate the characteristics of the magnetic materials.
4. Analyze the various types of dielectric materials based on the nature of electric field.
5. Apply optical properties of materials and semiconductor nanomaterials to various applications

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE201L.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
BEEE201L.2	2	1	-	-	-	-	-	2	2	1	-	-	-	-	-
BEEE201L.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
BEEE201L.4	3	3	2	2	-	-	-	2	2	1	-	-	2	-	-
BEEE201L.5	3	2	1	1	-	-	-	2	2	1	-	-	1	-	-

BEEE202L	Electromagnetic Theory	ILITIPIC
		2 1 1 0 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, waveguides and applications of electromagnetic fields.

Course Outcomes:

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

1. Identify an appropriate coordinate system for the given electromagnetic field problem
2. Apply concepts of electrostatics for electric field applications.
3. Apply principles of magnetostatics for magnetic field applications.
4. Determine the parameters of electrodynamic fields andapply Maxwell's equations for electromagnetic wave propagation.
5. Summarize 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 Gradient; divergence 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 compatibility		
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, 6th Edition, Oxford University Press, New York	
Reference Books		
1.	W H Hayt Jr, J A Buck &M Jaleel Akhtar, Engineering Electromagnetics, 2020, 9th 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	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE202L.1	3	2	1	1	-	-	-	2	2	1	-	1	2	-	-
BEEE202L.2	3	2	1	1	-	-	-	2	2	1	-	1	2	-	-
BEEE202L.3	3	2	1	1	-	-	-	-	-	-	-	1	2	-	-
BEEE202L.4	3	2	1	1	1	-	-	2	2	1	-	1	2	-	1
BEEE202L.5	2	1	-	-	-	-	-	-	-	-	-	1	-	-	-

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. Apply laws and theorems to estimate the steady state response for a given excitation
2. Analyse three-phase unbalanced systems in start and delta configurations
3. Examine transient and steady state responses of RL, RC and RLC circuits and network functions
4. Apply Laplace transform, Fourier series and Fourier transform in the electric network
5. Determine two port network parameters to simply 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, high 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, 7th edition, Mc Graw Hill Education	
2.	Ravish. R. Sinah, Network Analysis &Synthesis, 2019, 2nd Edition, Mc-Graw Education	
Reference Books		
1.	William Hayt, Jack Hemmerly, Jaime Phillips, Steven Durbin, Engineering Circuit Analysis, 2019, 9thedition, Mc Graw Hill Education	
2.	M.E Van Valkenbera, Network Analysis, 2019, Revised 3rd Edition, Pearson Publishers	
3.	Abhijit Chakrabarthi, Circuit Theory (Analysis and Synthesis), 2018, 7th Revised 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, 7th Edition, McGraw Hill Education	
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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE203L.1	3	2	1	1	1	-	-	2	2	1	-	1	2	-	1
BEEE203L.2	3	3	2	2	1	-	-	-	-	-	-	1	2	2	1
BEEE203L.3	3	3	2	2	1	-	-	2	2	1	-	1	2	2	1
BEEE203L.4	3	2	1	1	-	-	-	2	2	1	-	1	2	-	-
BEEE203L.5	3	2	1	1	-	-	-	-	-	-	-	1	2	-	-

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. Describe the discrete representations of continuous time signals using sampling theorem and its limitations.
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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE204L .1	3	2	1	1	1			1				1	1	2	1
BEEE204L.2	3	2	1	1	1			1	2	1		1	2		1
BEEE204L.3	3	2	1	1	1			1	2	1		1	2		1
BEEE204L.4	2	1	1	1	1			1							
BEEE204L.5	3	2	1	1	1			1	2	1		1	2		1

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 BJT and MOSFET based electronic circuits and their amplifier configurations.
3. Interpret frequency response of amplifiers.
4. Identify the impact of feedback in amplifier circuits..

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. D. A. Neaman, Microelectronics-Circuit Analysis and Design, 2016, 4th edition, McGraw Hill
3.

	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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE205L.1	3	2	1	1	1								3	3	
BEEE205L.2	3	3	2	2	1			2	2	1		2	3	3	1
BEEE205L.3	2	1			1							1	1		
BEEE205L.4	2	2			1			2	2	1			1		

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. 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE205P.1	3	3	2	2	2			2	2	2		1	3	3	1
BEEE205P.2	3	3	2	2	2			2	2	2		1	3	3	1

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 to solve real world problems.
2. Design 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. Identify various hazards and timing problems in sequential circuits

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 behavioral 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE206L.1	3	2	1	1	1			2	2	1		1	1	2	1
BEEE206L.2	3	2	1	1	1			2	2	1		1	1	2	1
BEEE206L.3	3	2	1	1	1							1	1	2	1
BEEE206L.4	3	3	2	2	1			2	2	1		1	1	2	1
BEEE206L.5	3	2	1	1	1										

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. Analyze synchronous and asynchronous sequential circuits.
3. Develop 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 behavioral 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE206P.1	3	2	1	1	1			2	2	2		1	1	2	1
BEEE206P.2	3	3	2	2	2			2	2	2		1	1	2	1
BEEE206P.3	3	2	1	1	1			2	2	2		1	1	2	1

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. Analyze the performance of differential amplifiers
3. Develop oscillators for the given frequency.
4. Analyze the performance characteristics and applications of Op-Amp.
5. Develop 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE208L.1	3	2										1	2	1	
BEEE208L.2	3	3	2	2	1			2	2	1		1	2	2	1
BEEE208L.3	3	2	1	1								1	2	2	
BEEE208L.4	3	3	2	2	1			2	2	1		1	2	2	1
BEEE208L.5	3	2	1	1	1	1		2	2	1		1	2	2	1

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. Develop differential amplifiers and oscillator circuits for engineering applications
2. Develop Op-Amp circuits for various engineering applications.
3. Construct timer circuits for real time applications.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE208P.1	3	2	1	1	2			2	2	2		1	2	2	1
BEEE208P.2	3	2	1	1	2			2	2	2		1	2	2	1
BEEE208P.3	3	2	1	1	2	1		2	2	2		1	2	2	1

Course code	DC Machines and Transformers	L	T	P	C
BEEE215L		2	0	0	2
Pre-requisite	BEEE102L, BEEE202L,BEEE102P	Syllabus version			
		v. 1.0			

Course Objectives

1. Understand the working principle of DC machines and Transformers
2. Acquire knowledge on the various parameters of DC machines and Transformers

Course Outcomes

1. Apply the principle of electromechanical energy conversion in single, multiple excited systems and rotating electrical machines.
2. Analyze the performance characteristics, speed control and testing of DC machines.
3. Analyze the performance characteristics and equivalent circuit parameters of single and three phase transformers.

Module:1	Electromechanical Energy Conversion	4 hours

Electromechanical energy conversion: Review of magnetic circuits; Lorentz's force law; Forces and torque in single and double excited magnetic systems; Determination of magnetic force, torque from energy and co-energy

Module:2	DC Generators	7 hours

Generator: Principle of operation, construction, armature windings, commutator; EMF equation; Types of DC generators; Critical field resistance and critical speed; Losses and efficiency; Armature reaction; Ampere turns per pole; Compensating winding; Methods of improving commutation; Generator characteristics and applications; Parallel operation and load sharing

Module:3	DC Motors	6 hours

Principle of operation, back EMF, torque equation, condition for maximum power developed; Types of DC motors; Various characteristics; Methods of speed control; Types of starters; Calculation of losses and efficiency; Testing of DC machines: Swinburne's test, brake test, regenerative testing and Hopkinson's test

Module:4	Single Phase Transformers	7 hours

Principle of operation, construction; Types of transformers; EMF equation; Leakage flux and leakage reactance; Operation of transformer under no load and on load; Phasor diagrams; Equivalent circuit; Losses and efficiency; Regulation and all-day efficiency; Testing of single-phase transformer: Polarity test, OC and SC test, back-to-back test; Parallel operation; Auto Transformer, Copper saving in auto transformer

Module:5	Three Phase Transformers	4 hours

Principle of operation, star to star, delta to delta, star to delta, delta to star, three phase to two phase, open delta connection, Scott connection; off load and on load tap changers; harmonic reduction in phase voltages

Module:6	Contemporary Issues	2 hours

Guest lecture from Industry and R & D Organizations

	Total Lecture hours:	30 hours

Text Book

1. A.E.Fitzgerald, Charles Kingsley, Jr, Stephen D Umans, "Electric Machinery'", 2017, 5th Edition, Tata McGraw Hill Education, India
2. Chapman, Stephen J "Electric machinery fundamentals", Tata McGraw Hill Education, 5th edition, 2012

Reference Books

1. DP Kothari, IJ Nagrath, '' Electric Machines", 2017, 5th Edition, Tata McGraw Hill Education, India
2. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016

Mode of Evaluation: CAT, assignment, Quiz, FAT		
Mode of assessment: Continuous assessment, FAT		
Recommended by Board of Studies	28-05-2022	
Approved by Academic Council	No. 67	08-08-2022

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE215L.1	3	2	1	1								1	2	2	
BEEE215L.2	3	3	2	1				2	2	1		1	2	2	
BEEE215L.3	3	3	2	1				2	2	1		1	2	2	

Course code	DC Machines and Transformers Lab	L	T	P	C
BEEE215P		0	0	2	1
Pre-requisite	BEEE102L, BEEE202L,BEEE102P	Syllabus version			
		v. 1.0			

Course Objectives

1. Understand the working principle of DC machines and Transformers
2. Acquire knowledge on the various parameters of DC machines and Transformers

Course Outcomes

1. Analyze the performance characteristics, speed control characteristics and testing of DC machines.
2. Analyze the performance characteristics and testing of single phase and three phase transformers.

Indicative Experiments		
1.	Open Circuit and load characteristics of DC Separately Excited Generator	
2	Load Characteristics of DC shunt generator	
3.	Load Characteristics of DC Compound Generators	
4.	Load Characteristics of DC Series Motors	
5.	Load Test on DC shunt Motor	
6.	Speed Control of DC Shunt Motor	
7.	Performance analysis of DC machines using Swinburne's Test	
8.	Performance analysis of DC machines using Hopkinson Test	
9.	Open circuit and short circuit test on single phase transformer	
10	Parallel Operation of single phase Transformers	
11	Load Test on Single Phase Transformers	
12	Three Phase Transformer and Scott connection of Transformer	
	Total Laboratory Hours	30 hours

Mode of assessment: Continuous assessment, FAT			
Recommended by Board of Studies	28-05-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE215L.1	3	3	2	2				2	2	2		1	2	2	
BEEE215L.2	3	3	2	2				2	2	2		1	2	2	

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. Understand the concepts of power semiconductor devices
2. Analyze the performance of single-phase and three-phase AC-DC converters.
3. Construct different types of DC -DC converters .
4. Analyze the performance of DC-AC converter with various modulation techniques.
5. Explain 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE301L.1	2	1										2	3	3	
BEEE301L.2	3	3	2	2	2			2	2	1		2	3	3	1
BEEE301L.3	3	2	1	1	2			2	2	1		2	3	3	1
BEEE301L.4	3	3	2	2	2			2	2	1		2	3	3	1
BEEE301L.5	2	1										1	1	1	

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. Apply transform techniques to analyze the discrete time systems.
2. Construct various structures for digital filter realization.
3. Develop IIR filters using transformation techniques and FIR filters using windowing techniques.
4. Explain filter operation in digital signal processors.
5. Implementing multi-rate signal processing techniques 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE302L.1	3	2	1	1	1			2	2	1		1		2	1
BEEE302L.2	3	2	1	1	1							1	2	2	1
BEEE302L.3	3	2	1	1	1			2	2	1		1	2	2	1
BEEE302L.4	2	1										2	1	1	
BEEE302L.5	3	2	1	1	1			2	2	1		1	2	2	1

BEEE302P	Digital Signal Processing Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEEE204L**	**Syllabus version**			
		1.0			

Course Objectives

1. Computation of FFT to communication systems.
2. Design IIR and FIR filters and interfacing of digital signal processor for real world application.

Course Outcomes

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

1. Simulation of continuous time and discrete time signals.
2. Develop of digital filters with real time constraints
3. Develop a typical digital signal processing system for specific applications in real world.

Indicative Experiments

1	Analysis of continuous time and discrete time signals
2	Convolution of discrete time signals
3	Correlation of discrete time signals
4	Computation of DFT
5	Spectral analysis of signals
6	Design of analog Butterworth filters
7	Design of analog Chebyshev filters
8	Design of an IIR elliptical band pass filter
9	Design of FIR filters using window functions
10	Waveform generation using CC studio of TMS320C6748
11	Computation of convolution using CC studio of TMS320C6748
12	ECG signal smoothening using CC studio of TMS320C6748 for real time applications
	Total Laboratory Hours **30** hours

Text Book

John G. Proakis, D. G. Manolakis, Digital Signal Processing Principles, Algorithms and Applications, 2016, 4th edition, Pearson Education

Reference Book

Lawrence R Rabiner and Bernard Gold, Theory and Application of Digital Signal Processing, 2016, 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE302P.1	3	2	1	1	2			2	2	2		1	2	2	1
BEEE302P.2	3	2	1	1	2			2	2	2		1	2	2	1
BEEE302P.3	3	2	1	1	2			2	2	2		1	2	2	1

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 the transfer function model for electrical, mechanical and electromechanical 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. Modelling of compensators and controllers to meet the performance specifications.
5. Develop a state space model for a given system.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE303L.1	3	2	1	1	1			1				1	2	3	1
BEEE303L.2	3	3	2	2	1			2	2	1		1	3	3	1
BEEE303L.3	3	2	1	1	1			2	2	1		2	3	3	1
BEEE303L.4	3	2	1	1	1			2	2	1		2	3	3	1
BEEE303L.5	3	2	1	1	1							1	3	3	1

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. Develop feedback control for meeting system specifications.
2. Analyze the stability and response of linear time invariant systems.
3. Analysis of first and second order systems in time and frequency domains.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE303P.1	3	2	2	1	2			2	2	2		1	3	3	2
BEEE303P.2	3	3	2	2	2			2	2	2		1	3	3	2
BEEE303P.3	3	3	2	2	2			2	2	2		1	3	3	2

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. Explain the concept of various conventional power generation systems.
2. Compute transmission line parameters of single and three phase transmission line.
3. Examine electrical equivalent models for transmission & distribution systems.
4. Analyze the performance of string insulators and line sag in overhead lines.
5. Calculate electricity tariff and capacitance required to improve the power factor.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE304L.1	2	1										1	1	1	
BEEE304L.2	3	2	1	1	1			2	2	1		1	3	3	1
BEEE304L.3	3	3	2	2	1			2	2	1		1	3	3	1
BEEE304L.4	3	3	2	2	1			2	2	1		1	3	3	1
BEEE304L.5	3	2	1	1	1							2	3	3	1

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. Explain the constructional features and various errors in the measurement system.
2. Explain the operation of meters for measurement of electrical variables.
3. Construct DC and AC bridges for measurement of various electric circuit constants.
4. Analyze various transducers for measurement process based on the applications.
5. Outline the significance and working of digital instruments and Virtual Instrumentation system

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE305L.1	2	1										1	1	1	
BEEE305L.2	3	2	1	1	1			2	2	1		1	3	3	
BEEE305L.3	3	2	1	1	1			2	2	1		1	3	3	
BEEE305L.4	3	3	2	2	1			2	2	1		1	3	3	
BEEE305L.5	3	2	1	1	2							2	3	3	2

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. Practice calibration of electrical measurement systems.
2. Measure various electrical and physical parameters.
3. Develop an efficient measurement system 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE305P.1	3	2	1	1	2			2	2	2		1	2	2	2
BEEE305P.2	3	3	2	2	2			2	2	2		1	3	3	2
BEEE305P.3	3	2	1	1	3			2	2	2		2	3	3	3

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. Compute the network matrices and load flow solutions for power systems.
2. Analyze different types of faults in power system network.
3. Analysis of stability issues in power system network
4. Investigation of Protection scheme and relaying for power system.
5. Summarize 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE306L.1	3	2	1	1	1							1	3	3	1
BEEE306L.2	3	3	2	2	1			2	2	1		1	3	3	1
BEEE306L.3	3	3	2	2	1			2	2	1		1	3	3	1
BEEE306L.4	3	2	1	1	1			2	2	1		2	3	3	1
BEEE306L.5	2	1										2	2	2	1

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. Analyze the reactive power requirement of a typical AC system to operate within nominal voltage and power factor limits.
2. Apply load flow analysis to an electrical power grid and interpret the results.
3. Selection of circuit breaker 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE306P.1	3	3	2	2	2			2	2	2		1	3	3	2
BEEE306P.2	3	2	1	1	2			2	2	2		1	3	3	2
BEEE306P.3	3	3	2	2	2			2	2	2		1	3	3	2

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. Explain 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. Outline 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE307L.1	2	1										1	2	2	
BEEE307L.2	3	3	2	2	1			2	2	1		1	3	3	1
BEEE307L.3	3	3	2	2	1			2	2	1		1	3	3	1
BEEE307L.4	2	1			1							1	2	3	1
BEEE307L.5	3	2	1	1				2	2	1		1	3	3	

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. Choose the suitable power electronic converter for various applications.
2. Analyze the performance characteritics of DC drives with various control methods.
3. Examine the control techniques of AC drives to verify the system performance.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE307P.1	3	2	1	1	2			2	2	2		2	3	3	2
BEEE307P.2	3	3	2	2	2			2	2	2		1	3	3	2
BEEE307P.3	3	3	2	2	2			2	2	2		2	3	3	2

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. Outline the concept of modulation.
2. Examine the properties of random processes.
3. Develop of transmitters and receivers for analog communication systems.
4. Apply the shift keying and pulse modulation techniques in various communication systems.
5. Explain 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE308L.1	2	1											2	2	
BEEE308L.2	3	3	2	2	1			2	2	1			2	2	1
BEEE308L.3	3	2	1	1	1			2	2	1		1	3	3	1
BEEE308L.4	3	2	1	1	1			2	2	1		1	3	3	1
BEEE308L.5	2	1										1	2	2	

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. Interpret the architecture of 8051 microcontroller and its instruction set.
2. Develop 8051 microcontroller program with suitable instructions.
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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE309L.1	2	1			1							1	2	2	1
BEEE309L.2	3	2	1	1	1			2	2	1		1	3	3	1
BEEE309L.3	3	2	1	1	1			2	2	1		1	3	3	1
BEEE309L.4	2	1			1							1	2	2	1
BEEE309L.5	3	3	2	2	1			2	2	1		1	3	3	1

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 structured assembly programs using microcontroller.
2. Implement C language programming for processor and controller.
3. Analyze the perfromance of 8051 and ARM processor for various 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE309P.1	3	2	1	1	2			2	2	2		2	3	3	2
BEEE309P.2	3	2	1	1	2			2	2	2		2	3	3	2
BEEE309P.3	3	3	2	2	2			2	2	2		2	3	3	2

Course code	AC Machines	L	T	P	C
BEEE312L		2	0	0	2
Pre-requisite	BEEE215L, 215P	Syllabus version			
		v. 1.0			

Course Objectives

1. Impart the concepts of AC machines
2. Analyse the performance characteristics asynchronous and synchronous machines

Course Outcome

1. Explain the construction and working principle of synchronous and asynchronous machines.
2. Analyse the performance characteristics of synchronous and asynchronous machines
3. Calculate the percentage efficiency and regulation of synchronous and asynchronous machines using appropriate testing methods.

Module:1	Poly-phase Induction Machine	4 hours

Concept of Rotating magnetic field; Construction, Working principle and Applications; Types of motor, SCIM, SRIM; Torque equation and their relationships; Effect of rotor resistance on performance of motor; Starters of poly-phase induction motor; Methods of speed control; Cogging & Crawling; Induction Generator; Load and Power factor control. Introduction to linear induction motor

Module:2	Testing of Poly-phase Induction Machine	4 hours

Operating parameters at different load; Condition for maximum torque, Losses and efficiency, No-load & blocked rotor test; Equivalent circuit; Phasor diagram; Performance analysis from Circle diagram; Separation of losses

Module:3	Single phase A. C. motors	5 hours

Single-phase induction motor: Construction and working; double revolving field theory; equivalent circuit diagram; torque-speed characteristic; starting and running performance; Types of single-phase motors: Principle and operation of split phase, Resistance start, Capacitor start and capacitor start & run induction motor, Shaded pole induction motor, fractional horse power motors, Universal motor, Repulsion motor; Introduction to Magnetic levitation systems

Module:4	Synchronous Generator	8 hours

Construction and Working principle; Equation of induced emf: pitch factor, distribution factor, MMF of distributed windings; Excitation system of Synchronous Machines; Phasor diagram of alternator; Voltage regulation of alternator: EMF method, MMF method and ZPF method; Power flow and maximum power condition; Reactive Power; Operating Characteristics of Alternator and their ratings; Synchronization power and characteristics; Synchronous Machine Stability: Load angle and Power flow equations

Module:5	Synchronous Motor	7 hours

Principle of operation; Phasor diagram; Methods of starting of synchronous motors; Hunting and Damper winding; Different torques in Synchronous motor; Synchronization torque; Effect of change in torque, effect of change in excitation; V-curve, Inverted V-Curve; Applications: Power factor correction, Voltage Regulation and Synchronous phase modifiers; Slip test for measurement of direct axis and quadrature axis reactance in salient pole machine

Module:6	Contemporary Issues	2 hours

Guest lecture from industry and R & D Organizations

	Total Lecture hours:	30 hours

Text Books

1. A.E.Fitzgerald, Charles Kingsley, Jr, Stephen D Umans, “Electric Machinery’”, 2017, 5th Edition, Tata McGraw Hill Education, India
2. Chapman, Stephen J "Electric machinery fundamentals”, Tata McGraw Hill Education, 5th edition, 2012

Reference Books

1. DP Kothari, IJ Nagrath, ‘’ Electric Machines”, 2017, 5th Edition, Tata McGraw Hill Education, India
2. Vincent Del Toro, ‘Basic Electric Machines’ Pearson India Education, 2016

3.	M.N. Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2009		
Mode of Evaluation: CAT, assignment, Quiz and FAT			
Recommended by Board of Studies :28-05-2022			
Approved by Academic Council	No.67	08-08-2022	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE312L.1	3	2	1	1								1	1	1	
BEEE312L.2	3	3	2	2				2	2	1		1	2	2	
BEEE312L.3	3	3	2	2				2	2	1		1	2	2	

Course code	AC Machines Lab	L	T	P	C
BEEE312P		2	0	0	2
Pre-requisite	BEEE215L, 215P	Syllabus version			
		v. 1.0			

Course Objectives

1. Impart the concepts of AC machines
2. Analyse the performance characteristics asynchronous and synchronous machines

Course Outcome

1. Analyze the performance characteristics of synchronous machines by conducting suitable experiments.
2. Analyze the performance characteristics of Induction machines by conducting suitable experiments.

Indicative Experiments		
1.	Regulation of Alternator by EMF and MMF Methods	
2.	Regulation of Alternator by Potier triangle/ZPF Method	
3.	Load Test on Three Phase Alternator	
4.	Synchronization of Three Phase Alternator on infinite busbar	
5.	V- Curves and inverted V-curves for Synchronous Motor	
6	Load Test on Three Phase Squirrel cage Induction Motor	
7	Load Test on Three Phase Slip-ring Induction Motor	
8	Performance evaluation of Three-Phase Induction Motor from Circle Diagram.	
9	Load Test on Three Phase Induction Generator	
10	Load test on Single Phase Induction Motor	
11	Slip test on Alternator	
12	Parallel operation of Synchronous generator	
	Total Laboratory Hours	30 hours

Mode of assessment: Continuous assessment, FAT ,Oral examination			
Recommended by Board of Studies	28-05-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE312L.1	3	3	2	2				2	2	2		1	2	2	
BEEE312L.2	3	3	2	2				2	2	2		1	2	2	

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. Explain the importance of magnetic, thermal and electric loadings.
2. Develop of magnetic circuit for static and rotating electrical machines.
3. Model a transformer as per the requirements and constraints specified
4. Develop stator and rotor parts of the DC machines
5. Develop parameters of AC machines.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE210L.1	2	1										1	2	2	1
BEEE210L.2	3	2	2	1	1			2	2	1		1	3	3	1
BEEE210L.3	3	2	2	1	1			2	2	1		1	3	3	1
BEEE210L.4	3	2	2	1	1			2	2	1		1	3	3	1
BEEE210L.5	3	2	2	1	1			2	2	1		1	3	3	1

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE211E.1	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
BEEE211E.2	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
BEEE211E.3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
BEEE211E.4	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-

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. Apply dynamic and convex programming tools to solve optimization problems
4. Develop optimization methods for neural networks.
5. Build natural inspired algorithms for engineering optimization problems.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE212L.1	3	2	1	1	1			2	2	1		1	1	1	1
BEEE212L.2	3	2	1	1	1							1	1	1	1
BEEE212L.3	3	2	1	1	1			2	2	1		1	1	1	1
BEEE212L.4	3	2	1	1	2			2	2	1		1	2	2	2
BEEE212L.5	3	2	1	1	1							1	2	2	1

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. Outline the characteristics and concepts of embedded systems and ARM Cortex-M microcontrollers.
2. Develop embedded software using commercial integrated development environments
3. Apply suitable communication protocols to interface sensors and actuators
4. Utilize 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE213L.1	2	1			1							1	2	2	1
BEEE213L.2	3	2	1	1	1			2	2	1		2	3	3	1
BEEE213L.3	3	2	1	1	1			2	2	1		1	3	3	1
BEEE213L.4	3	2	1	1	1			2	2	1		2	3	3	1
BEEE213L.5	3	2	1	1	1							1	3	3	1

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE310L.1	3	2	1	1	-	-	-	-	-	1	-	1	2	-	2
BEEE310L.2	3	2	1	1	2	-	-	1	1	-	-	-	-	2	1
BEEE310L.3	3	2	1	-	2	-	-	-	-	1	-	1	1	2	2
BEEE310L.4	3	2	1	1	1	-	-	1	1	-	-	-	-	2	-
BEEE310L.5	3	2	1	1	1	-	-	-	-	1	-	1	1	2	2

Course Code	Course Title	L	T	P	C
BEEE31ꞱL	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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE311L.1	3	2	2	2								1	1		
BEEE311L.2	3	2	2	2								1	1	1	
BEEE311L.3	3	2	2	2								1	1		
BEEE311L.4	3	2	2	2								1	1	1	
BEEE311L.5	3	2	2	2								1	1		

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 problems related to society
2. Apply appropriate technology(ies) to address the identified problems using engineering principles and arrive at innovative solutions
3. Examine the system components to provide a solution for the identified issues.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE391J.1	3	2	1	1	2	1		2	2	2	2	2	2	2	2
BEEE391J.2	3	2	1	1	2			2	2	2	2	2	2	2	2
BEEE391J.3	3	3	2	2	2	1	1	3	3	3	3	2	3	3	2

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. Apply new skills to make new prototype or working model.
2. Utilize the techniques, skills, and modern tools necessary for the project.
3. Examine the creativity and insight to better understand and improve the 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE392J.1	3	2	1	1	2			2	2	2	2	2	3	2	2
BEEE392J.2	3	2	1	1	2			2	2	2	2	2	2	2	2
BEEE392J.3	3	3	2	2	2	1	1	3	3	3	3	2	3	3	2

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. Conduct experiments to gain hands-on experience on the concepts studied
2. Analyse the experimental data to obtain optimal solutions
3. Summarize the results in the form of technical report

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE393J.1	3	2	1	1	2			2	2	2	2	2	3	2	2
BEEE393J.2	3	3	2	2	2	1	1	3	3	3	3	2	3	3	2
BEEE393J.3	2	1			2			2	3	2	2	2			2

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.Analyze the techniques to convert a developed prototype/working model to a viable product useful to society/industry
2.Apply the appropriate codes/regulations/standards during product development
3.Summarize key findings through 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE394J.1	3	3	2	2	2	2	1	3	3	3	3	2	3	3	2
BEEE394J.2	3	2	1	1	2			2	2	2	2	2	3	2	2
BEEE394J.3	2	1			2			2	3	2	2	2			2

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. Interpret published literature/books providing information related to niche areas/focused domains
2. Examine technical literature to resolve ambiguity, and develop conclusions.
3. Apply insight and creativity to integrate knowledge for a better understanding of the domain of interest.

Module Content

This is oriented towards reading published literature or books related to niche areas or focused 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE396J.1		3		2		2			2	3		2			
BEEE396J.2		3		2		2			2	3		2			
BEEE396J.3		3		2		2			2	3		2			

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. Solve problems using appropriate information and approaches within a time-bound framework
2.Analyze major approaches, concepts, and current research findings in the area of interest

3.Construct the 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE397J.1	3	2	1	1	2			2	2	2	2	2	3	2	2
BEEE397J.2	3	3	2	2	2	1	1	3	3	3	3	2	3	3	2
BEEE397J.3	3	2	1	1	2			2	2	2	2	2	3	2	2

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. Apply the skills to simulate and critically analyse the working of a real system.
2. Identify and explore the different variables which affect the system
3. Analyze 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE398J.1	3	2	1	1	2			2	2	2	2	2	3	2	2
BEEE398J.2	3	2	1	1	2			2	2	2	2	2	3	2	2
BEEE398J.3	3	3	2	2	2	1	1	3	3	3	3	2	3	3	2

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. Outline grounding, relays characteristics and protection schemes
2. Identify appropriate protection schemes for different power system components
3. Select an appropriate type of circuit breaker based on its ratings and interruption time
4. conduct experiment for the relaying and protectionschemes of variohs power system components.

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
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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE401E.1	2	1										1	2	2	
BEEE401E.2	3	2	1	1				2	2	1		1	3	3	1
BEEE401E.3	3	2	1	1				2	2	1		1	3	3	1
BEEE401E.4	3	2	1	1	1			2	2	2		1	3	3	1

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		
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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE402L.1	3	3	1	1	1	-	-	1	1	-	-	1	1	1	1
BEEE402L.2	3	2	1	1	1	-	-	-	-	-	-	2	1	2	1
BEEE402L.3	3	2	2	1	1	-	-	-	-	-	-	1	1	1	1
BEEE402L.4	3	3	2	1	1	-	-	1	1	-	-	1	1	1	1
BEEE402L.5	3	1	1	1	1	-	-	-	-	-	-	2	1	1	1

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		
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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE403L.1	3	2	2	1	-	-	-	1	1	-	-	1	1	2	-
BEEE403L.2	3	1	1	1	-	-	-	1	1	-	-	1	1	2	-
BEEE403L.3	3	2	2	1	-	-	-	1	1	-	-	1	1	2	-
BEEE403L.4	3	2	2	1	-	-	-	1	1	-	-	1	1	2	-

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	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE404L.1	3	2	2	2	-	-	-	-	1	1	-	1	1	1	-
BEEE404L.2	3	2	2	2	-	-	-	-	1	1	-	1	1	1	-
BEEE404L.3	3	2	1	1	-	-	-	-	1	1	-	1	1	1	-
BEEE404L.4	3	2	2	2	-	-	-	-	1	1	-	1	1	1	-
BEEE404L.5	3	2	2	2	-	-	-	-	1	1	-	1	1	1	-

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. Explain the different types of renewable energy sources
2. Build solar and wind energy conversion systems for stand alone and grid connected systems.
3. Develop tidal and wave energy conversion systems.
4. Classify the different types of geothermal energy and biomass energy
5. Illustrate the principle of operation and applications of various 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE405L.1	2	1										1			
BEEE405L.2	3	2	1	1	1			2	2	1		1	2	2	1
BEEE405L.3	3	2	1	1	1			2	2	1		1	2	2	1
BEEE405L.4	2	1						1				1	2	2	
BEEE405L.5	2	1						1	1	1		2	2	2	

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE406L.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
BEEE406L.2	3	3	2	2	2	-	-	-	3	3	-	3	-	-	-
BEEE406L.3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
BEEE406L.4	3	2	1	1	1	-	-	-	3	3	-	3	-	-	-
BEEE406L.5	3	2	1	1	1	-	-	-	3	3	-	3	-	-	-

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE407L.1	3	1	1	1	-	-	-	-	1	-	-	-	1	1	-
BEEE407L.2	3	3	2	1	-	-	-	1	1	-	-	1	1	1	-
BEEE407L.3	3	1	1	1	-	-	-	-	1	-	-	-	1	1	-
BEEE407L.4	3	3	2	1	-	-	-	1	1	-	-	1	2	3	-
BEEE407L.5	3	3	2	2	-	-	-	1	2	-	-	1	2	3	-

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE408L.1	3	2	1	-	-	-	-	-	-	-	-	2	-	2	-
BEEE408L.2	3	2	1	-	-	-	-	-	-	-	-	2	-	-	-
BEEE408L.3	3	3	2	-	-	-	-	2	-	-	-	2	2	2	-
BEEE408L.4	3	3	2	-	-	-	-	2	-	-	-	2	2	2	-
BEEE408L.5	3	3	2	-	-	-	-	-	-	-	-	2	2	2	-

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. Explain the forward and inverse kinematic of robot manipulators
2. Develop the dynamics of the robotic manipulator using Euler Lagrangian approach
3. Construct joint trajectories for motion planning in robotic systems.
4. Develop 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 Edition, 2017
3.	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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE409L.1	2	1	-	-	-	-	-	-	-	-	-	1	2	2	-
BEEE409L.2	3	2	1	1	-	-	-	2	2	1	-	1	3	3	-
BEEE409L.3	3	2	1	1	1	-	-	2	2	1	-	1	3	3	1
BEEE409L.4	3	2	1	1	1	-	-	-	-	-	-	1	3	3	1
BEEE409L.5	3	2	1	1	1	-	-	2	2	1	-	1	3	3	1

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.
3. Utilize PCA and ICA for dimensionality reduction problems.
4. Develop solutions for sequential decision making problems.
5. Develop 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	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE410L.1	3	2	1	1	1							1	1	1	1
BEEE410L.2	3	2	1	1	1			2	2	1		1	1	1	1
BEEE410L.3	3	2	1	1	1			2	2	1		1	1	1	1
BEEE410L.4	3	2	1	1	1			2	2	1		1	1	1	1
BEEE410L.5	3	2	1	1	1							1	2	2	1

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. Explain Various Artificial Intelligence methods and describe their foundations
2. Apply problem solving and search algorithms to solve engineering problems
3. Apply constrain satisfaction techniques for optimization problems.
4. Illustrate the knowledge representation methods and its applications.
5. Apply reasoning, planning techniques and decision making solution.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE411L.1	2	1										1	1	1	
BEEE411L.2	3	2	1	1	1			2	2	1		1	2	2	1
BEEE411L.3	3	2	1	1	1			2	2	1		1	1	1	1
BEEE411L.4	2	1										1	1	1	
BEEE411L.5	3	2	1	1	1			2	2	1		1	1	1	1

Course Code	Course Title	L	T	P	C
BEEE417L	Advanced Microcontroller	3	0	0	3
Pre-requisite	BEEE309L, BEEE309P	Syllabus version			
		1.0			

Course Objectives

1. Articulate the hardware functionality of ARM Processor
2. Build the knowledge about various modules of ARM processor & its programming
3. Create an interface program for several ARM processor peripherals

Course Outcomes

1. Understand the architecture of ARM and its instruction set
2. Develop programs for various blocks of ARM processor
3. Knowledge of communication protocols for different applications
4. Develop parallel processing applications and knowledge about exceptions
5. Analyse and solve real time problems using ARM processor

Module:1	Introduction to ARM Processor	5 hours

ARM processor architecture and pipelining; programmer's model; data paths and instruction decoding; Modes of Operations of ARM; Advanced Microcontroller Bus architecture; ARM instruction set; addressing modes; Simple programming

Module:2	Peripherals of ARM	6 hours

General Purpose Input and Output (GPIO); Fast GPIO; Analog to Digital Converter (ADC); Digital to Analog Converter (DAC); Programming

Module:3	Timers and PWM	6 hours

Different modes of operation of Timers; Match Registers; Generation of PWM using Compare registers; Capture Control; Single and Double Edge Controlled PWM; Programming

System Control; Real Time Clock (RTC), Watch Dog Timer (WDT) , USB 2.0 Full-Speed device controller with DMA

Module:5	Communication Interface	6 hours

Universal Asynchronous Receiver Transmitter (UART), Inter Integrated Circuit (I2C) Bus Serial Interface, Serial Peripheral Interface (SPI), Synchronous Serial Port (SSP) Serial Interfaces; Programming

Module:6	Exception and Interrupt Handling	5 hours

Exception handling overview; Interrupts; Interrupt Handling Schemes; Nested Interrupt Handler; Vectored Interrupt Controller; FIQ and IRQ modes of operation

Module:7	Interrupts with different peripherals	9 hours

External Interrupt, Timer Interrupt, PWM Interrupt, ADC Interrupt, UART interrupt, Watch Dog Timer Interrupt, I2C Interrupt, SPI Interrupt, SSP Interrupt, RTC Interrupt, Brown Out Detect (BOD), USB Interrupt; Utility of interrupts in closed loop control of a real time system; programming

Module:8	Contemporary Issues	2 hours
Guest lecture from Industry and R & D Organizations		

Text Book(s)

1. Andrew N.Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software" Morgan Kaufmann Publishers, 2011.
2. Ata Elahi, Trevor Arjeski "ARM Assembly Language with Hardware Experiments", Springer 2015

Reference Books

1. William Hohl, Christopher Hinds "ARM Assembly Language – Fundamentals and Techniques" Second Edition, CRC Press Taylor & Francis Group 2015.
2. Tahir, Muhammad, Javed, Kashif, "ARM Microprocessor Systems: Cortex-M Architecture, Programming, and Interfacing" CRC Press Taylor & Francis Group, 2017

Mode of Evaluation: CAT, Written Assignment, Quiz, FAT, Project, Seminar, Group Discussion

Recommended by Board of Studies	30-10-2023		
Approved by Academic Council	No. 72	Date	13-12-2023

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE417L.1	2	1										1	1		
BEEE417L.2	3	2	1	1	1			1	1			1	2		1
BEEE417L.3	3	1										1	1		
BEEE417L.4	2	2	1	1	1			1	1			1	1		1
BEEE417L.5	3	2	1	1	1			1	1			1	2		1

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 using principles of mathematics.
2. Select appropriate diagnostic instruments and advanced techniques for diagnosis.
3. Explain the operation of therapeutic devices in medical practices.
4. Analyze the blood parameters using clinical instruments.
5. Explain the basic principles of medical imaging techniques.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEIE301L.1	3	3	2	2				2	2	1		1	1	1	
BEIE301L.2	3	2	1	1				2	2	1		1	1	1	
BEIE301L.3	2	1											1	1	
BEIE301L.4	3	3	2	2				2	2	1		1	1	1	
BEIE301L.5	2	1											1	1	

		L	T	P	C
BEEE416L	**Electric Vehicles**	**3**	**0**	**0**	**3**
Pre-requisite	**BEEE307L, BEEE307P**	Version			
		1.0			

Course Objectives:

1. This course introduces the fundamental concepts, principles, analysis and design of hybrid electric vehicles.

Course Outcome:

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

1. Comprehend the performance of conventional vehicles.
2. Infer the hybrid electric vehicles and its impact on environment
3. Analyze the various hybrid vehicle configurations and its performance.
4. Interpret the electric components used in hybrid and electric vehicles
5. Design the sizing of drive systems for electric vehicles.
6. Choose proper energy storage systems for vehicle applications
7. Identify various communication protocols and technologies used in vehicle networks
8. Design a component or a product applying all the relevant standards with realistic constraints.

Module:1	**Introduction to Conventional Vehicles**	**3 Hours**

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance

Module:2	**Introduction to Electrical Vehicles**	**3 Hours**

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, future of electric vehicles, comparison with IC engine drive vehicles

Module:3	**Electric Vehicle Drive Train**	**4 Hours**

Transmission configuration, Components, gears, differential, clutch, brakes, regenerative braking, motor sizing. Basic concept of electric traction, Introduction to various drive train topologies, power flow control in electric drive topologies, fuel efficiency analysis

Module:4	**Electric Propulsion Unit**	**4 Hours**

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module:5	**Sizing the drive system**	**3 Hours**

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Module:6	**Energy Storage**	**4 Hours**

Introduction to energy storage requirements in hybrid and Electric vehicles, Battery

based energy storage and its analysis, fuel cell based and super capacitor based energy storage and its analysis. Hybridization of different energy storage devices				
Module:7	**Energy management strategies and Case Studies**			**7 Hours**
Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies - Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).				
Module:8	**Contemporary Issues**			**2 Hours**
	Total Lecture Hours			**30 Hours**
Text Book(s)				
1.	Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, Second Edition, 2011.			
2.	Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.			
Reference Books				
1.	Chris Mi, MA Masrur, and D W Gao, "Hybrid Electric Vehicles- Principles and Applications with Practical Perspectives", Wiley, 2011.			
2.	Davide Andrea, "Battery management Systems for Large Lithium-Ion Battery Packs", Artech House, 2010.			
Mode of Evaluation:	CAT I & II – 30%, DA I & II – 20%, Quiz – 10%, FAT – 40%			
Recommended by Board of Studies	30-10-2023			
Approved by Academic Council	No. 72	Date	13-12-2023	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE416L.1	2	1					2					1	1	1	
BEEE416L.2	2	1					2					1	2	2	
BEEE416L.3	3	3	2	2	1			2	2	1		1	2	2	1
BEEE416L.4	2	1										1	2	2	
BEEE416L.5	3	2	1	1	1			2	2	1		1	2	1	1
BEEE416L.6	3	2	1	1	1			2	2	1		1	2	1	1
BEEE416L.7	2	1										1	2	2	
BEEE416L.8	2	1										1	2	2	

Course Code	Course Title	L	T	P	C
BEEE415L	Smart Grid	3	0	0	3
Pre-requisite	BEEE304L, BEEE307L, BEEE307P	Syllabus version			
		1.0			

Course Objectives:

1. Architecture designs
2. Measurement and Communications Technologies
3. To familiarize the transmission and distribution automation using smart Grid.
4. Integration of vehicles with rechargeable batteries in to distribution networks.

Course Outcomes:

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

1. Describe the necessity and evolution of smart grid with policies
2. Identify the appropriate measurement techniques for smart grid implementation
3. Apply theoretical concepts for analyzing the performance of the grid
4. Identify the appropriate choice for data transaction in a secure manner
5. Understand various power transmission automation techniques
6. Explain the working of distribution automation and the two way power flow of distribution system
7. Design the concept of V2G & G2V using Electric vehicle & Batteries
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	Smart Grid Architectural Designs	7 Hours

Introduction. Evolution of electric Grid, Need for smart grid, difference between Conventional grid and smart grid, General View of the Smart Grid Market Drivers, Functions of Smart Grid Components, present development and international policies in smart grid.

Module:2	Smart Grid Communications And Measurement Technology	8 Hours

Communication and Measurement , Monitoring, PMU, Smart Meters, and Measurements Technologies ,Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) , Smart Meters , Smart Appliances, Advanced Metering Infrastructure (AMI),, GIS and Google Mapping Tools Multi agent Systems (MAS) Technology ,Multi agent Systems for Smart Grid Implementation , Micro grid and Smart Grid Comparison

Module:3	Performance Analysis Tools For Smart Grid Design	6 Hours

Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods ,types ,Load Flow State of the Art: Classical, Extended Formulations, and Algorithms , Congestion Management Effect , Load Flow for Smart Grid Design , Cases for the Development of Stochastic Dynamic optimal Power Flow (DSOPF), Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingency Studies for the Smart Grid

Module:4	Information Security And Communication Technology For Smart Grid	6 Hours
Data communication, switching techniques, communication channels, HAN,NAN,WAN, Bluetooth, Zigbee, GPS, Wi-Fibased communication, Wireless mesh network, Basic of cloud computing and cyber security for smart grid, Broadband over power line(BPL)		
Module:5	**Transmission Automation**	**7 Hours**
Introduction, Transmission Infrastructure functionality, Transmission technology , Energy Management System , Map Board Automatic Generation Control (AGC) ,Supervisory Control , Contingency Reserve Management ,Interchange Scheduling , SCADA Master Terminal Unit , Transmission Substations, Synchrony phasor as IEDs , Relays as IEDs ,Programmable Logic Controllers as IEDs ,RTUs as IEDs, Smart Transmission Cyber Security.		
Module:6	**Distribution Automation**	**6 Hours**
Introduction , Distribution System Architecture, Distribution automation, working of Distribution Automation, ,role of Smart Grid Function of Distribution Automation, Importance of the Distribution System and Its Security Challenges ,Securing the Distribution System, Distribution Management Systems ,Standards, Inoperability, and Cyber Security		
Module:7	**Integration Of Vehicles With Rechargeable Batteries Into Distribution Networks**	**3 Hours**
The revolution of individual electrical transport, consequences on the electrical network. Demand management and vehicle-to-grid, Vehicles as "active loads" Energetic services, Frequency regulation.		
Module:8	**Contemporary Issues**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	James momoh, "Smart grid fundamentals of design and analysis, "IEEE Press, a john wiley & sons, inc., publication, 2012.
2.	Bernd M. Buchholz, Zbigniew Styczynski ,"Smart grid fundamentals and Technologies in Electricity Networks", Springer ,Heidelberg New York Dordrecht London, 2014.
Reference Books	
1.	Janaka Ekanayake, Nick Jenkis, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smard grid technology and applications,: Wiley, 2012.
2.	Stuart Borlase " Smart grid: Infrastructure, Technology and solutions, "CRC Press 2012.

Mode of Evaluation:	CAT I & II – 30%, DA I & II – 20%, Quiz – 10%, FAT – 40%		
Recommended by Board of Studies	30-10-2023		
Approved by Academic Council	No. 72	Date	13-12-2023

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE415L.1	2	1										1	2	2	
BEEE415L.2	3	2	1	1				2	2	1		1	3	3	
BEEE415L.3	3	2	1	1	1			2	2	1		1	3	3	1
BEEE415L.4	2	1			1							1	2	2	1
BEEE415L.5	2	1			1							1	2	2	1
BEEE415L.6	2	1			1							1	2	2	1
BEEE415L.7	2	1			1			2	2	1		1	2	2	1
BEEE415L.8	2	1			1							1	2	2	1

Course Code	Course Title	L	T	P	C
BECE320E	Embedded C Programming	2	0	2	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To impart logical thinking and fundamental problem-solving skills via the use of a programming language.
2. To develop basic and advanced programming concepts using C and Embedded C language.
3. To interface with microcontroller using Embedded C language.

Course Outcomes

The student will be able to

1. Apply the C programming language for various data types and decision making applications.
2. Comprehend the derived data types, pointers and creation of functions.
3. Describe the architecture of 8051 microcontroller for programming & interfacing applications.
4. Write the embedded C code to 8051 for programming I/O ports, timers, serial communication, interrupt and interfacing external peripherals.
5. Develop microcontroller based applications.

Module:1	Introduction to C	3 hours

Introduction to Embedded C, difference between C and Embedded C. Introduction to C programming, comments, identifiers, variables, headers, data types, operators, order of operations, format specifies, escape sequence characters, input and output statements, programs on sequential statements.

Module:2	Control and loop statements	4 hours

Control statements: if, if-else, if-else ladder, elseif ladder, switch. Loops: do-while, while, for loops and nested loops. Break, continue, goto and exit statements. Programs on if, switch and loops.

Module:3	Arrays and strings	3 hours

Arrays: one dimensional and multi-dimensional array, programs on arrays. Strings, functions, pointers.

Module:4	Introduction to 8051 microcontroller	6 hours

Introduction to microcontroller, difference between microcontroller and microprocessor, 8051 : architecture, pin diagram of 8051, memory organization, special function registers, I/O pins ,timers, interrupts, serial interface, power consumption, external interface of the standard 8051.

Module:5	8051 programming in C	4 hours

Data types: sbit, sfr, and bit. Producing delay using loops, programming I/O ports: bit addressable and byte addressable programming, programs on sending and receiving data through I/O ports. Programs on logic operations, data conversion, data serialization with I/O ports.

Module:6	Timer and serial port programming	4 hours

Programs on accessing timers registers, programs on producing time delay using mode 1 and mode 2, programs on generating various clock frequencies, programming of timers 0 and 1 as counters. Serial port programming: transmitting

and receiving data with different baud rates. Programs on timer and Serial communication interrupts.		
Module:7	**Interfacing with displays and sensors**	**4 hours**
Programming of keyboard interfacing, programming of LEDs interfacing, programming of seven segment display interfacing, interfacing circuit description and programming of 16 x 2 LCD, ADC, DAC and temperature sensor interfacing.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1	Mike McGrath, C Programming in easy steps, 2019, 4th Edition, In Easy Steps Limited.
2	Muhammad Ali Mazidi , Janice Gillispie Mazidi , Rolin McKinlay, 2014, The 8051 Microcontrollers & Embedded Systems , 2nd edition, Pearson.
Reference Books	
1.	Barrett, Michaell, and Ambony Massa. Programming Embedded Systems, with C and GNU Development Tools, 2020, O'Reilly Media.
2	Herbert Schildt, C: The Complete Reference, 2017, 4th Edition, McGraw Hill Education.
Mode of evaluation: Internal Assessment (CAT, quizzes, Digital Assignments) & Final Assessment Test (FAT)	
Lab Component :	
Indicative Experiments	

1	Programs on Sequential statements	2 hours
2	Programs on Condition and Control statements	2 hours
3	Programs on Arrays	2 hours
4	Programs on Strings & Functions	2 hours
5	Programs on I/O ports	2 hours
6	Programs on Timer/Counter	4 hours
7	Programs on serial communication	2 hours
8	Programs on Timer Interrupts	2 hours
9	Programs on Serial Communication Interrupts	2 hours
10	Programs on External interrupts	2 hours
11	Programs on interfacing Keypad and LCDs	4 hours
12	Programs on interfacing ADC, DAC and Sensors	4 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment and FAT			
Recommended by Board of Studies	07-11-2023		
Approved by Academic Council	No. 72	Date	13-12-2023

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BECE320E.1	2	1			3							2	2		3
BECE320E.2	3	2			3				2	2		2	2		3
BECE320E.3	3	2			3				2	2		2	2		3
BECE320E.4	2	2			3							2	2		3
BECE320E.5	2	1			3							2	2		3

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. Illustrate the importance of professional and ethical responsibility in Engineering practices.
2. Apply various techniques to assess 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE399J.1	2	1						2	2	2		2			
BEEE399J.2	3	2	1	1	2	3	3	2	2	2	2	2	2	2	2
BEEE399J.3	3	2	1	1	2	1	1	2	2	2	2	3	2	2	2
BEEE399J.4	2	1						2	2	2		2			

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. Illustrate the importance of professional and ethical responsibility in Engineering practices.
2. Analyse evidence to identify and recommend the best practices for implementation.
3. Apply mentoring strategies to support peers in achieving excellence in practice of the discipline.
4. Analyze collaborative approaches in multi-disciplinary works and provide effective solutions.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE497J.1	2	1						2	2	2		2			
BEEE497J.2	3	3	2	2	2	2	2	3	3	3	3	2	3	3	2
BEEE497J.3	3	2	1	1				2	2	2	1	2			
BEEE497J.4	3	3	2	2	2	2	2	3	3	3	3	2	3	3	2

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. Develop specific problem statements for ill-defined real life problems with reasonable assumptions and constraints
2. Explain the process of conducting literature search and / or patent search in the area of interest.
3. Design and Analysis/Conduct experiments/solution iterations and document the results.
4. Analysis of error/benchmarking / costing
5. Examine the results and arrive at scientific conclusions/products / solution
6. Summarize the results in the form of technical report / presentation

Module Content

1. Project may be a theoretical analysis, modeling & simulation, experimentation & analy- sis, 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 institu- tion.
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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BEEE498J.1	3	2	1	1		3	3	3	3	3	3	2	3	2	
BEEE498J.2	2	1			1			2	3	2	2	2			1
BEEE498J.3	3	3	2	2	2	2	2	3	3	3	3	2	3	3	2
BEEE498J.4	3	3	2	2	2	2	2	3	3	3	3	2	3	3	2
BEEE498J.5	3	3	2	2	2	2	2	3	3	3	3	2	3	3	2
BEEE498J.6	2	1			2			2	3	2	2	2			2

BCHY102N	Environmental Sciences	L	T	P	C
		0	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

The course is aimed at students to

1. Understand and appreciate the unity of life in all its forms and their implications of life style on the environment.
2. Identify the different causes for environmental degradation.
3. Analyze individual's contribution to environmental pollution.
4. Evaluate the impact of pollution at the global/local level and find solutions for remediation.

Course Outcomes

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

1. Recognize the environmental issues in a problem-oriented, interdisciplinary perspective.
2. Classify the key environmental issues, the science behind those problems and potential solutions.
3. Demonstrate the significance of biodiversity and its preservation.
4. Identify various environmental hazards.
5. Design various methods for the conservation of resources.
6. Formulate action plans for sustainable alternatives that incorporate science, humanity, and social aspects.

Module: 1	**Environment and Ecosystem**	**5 hours**

Environment: definition; Earth–life support system. Ecosystem definition, components and types. Key environmental problems, their basic causes and sustainable solutions. Food chain, food web and their significance, Energy flow in ecosystem; Ecological succession-stages involved, primary and secondary succession - hydrarch, mesarch, xerarch.

Module: 2	**Biodiversity**	**4 hours**

Biodiversity-definition, levels and importance. Species: roles: types: extinct, endemic, endangered and rare species. Hot-spots –Significance, Mega-biodiversity. Threats to biodiversity due to natural and anthropogenic activities, Conservation methods. GM crops-advantages and disadvantages.

Module: 3	**Sustaining Environmental Quality**	**4 hours**

Environmental hazards: definition, types, causes and solutions: Biological (Malaria, COVID-19), Chemical (BPA, heavy metals), and Nuclear (Chernobyl); Air, water and soil quality management and conservation; Solid waste management methods.

Module: 4	**Clean and Green Energy**	**5 hours**

Renewable energy resources: Solar energy-thermal and photovoltaic; Hydroelectric energy. Wind energy, Ocean thermal energy; Geothermal energy; Energy from biomass; Hydrogen energy; Solar-hydrogen revolution. Electric and CNG vehicles.

Module: 5	**Environmental Protection Policies**	**4 hours**

Environmental Protection (EPA) objectives; Air Act, water Act, Forest conservation Act and Wild life protection Act. Environmental Impact Analysis: guidelines, core values. Impact assessment methodologies.

Module: 6	**Sustainable development**	**4 hours**

Effect of population-urban environmental problems; Population age structure; Sustainable human societies: tools in economics, sustainable development goals SDGs and promoting awareness. Women and child welfare, Women empowerment.

Module: 7	**Global Climate Change**	**4 hours**
Global climate change and green-house effect. Kyoto Protocol-carbon credits, The Paris Agreement, carbon sequestration: definition, types and methodologies. Ozone layer depletion: causes and impacts. Mitigation of ozone layer depletion- Montreal Protocol. Role of Information Technology in environment.		
Total Lecture hours:		**30 hours**
Assessment: Seminars, Quiz, Case Studies, Final Assessment Test.		
Text Books		
1. G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengagelearning. 2. Benny Joseph, (2012), Environmental Science and Engineering, 5th Edition, Tata McGraw Hill Education Private Limited, New Delhi, India.		
Reference Book(s)		
1. David M. Hassenzahl, Mary Catherine Hager, Linda. R. Berg (2011), Visualizing Environmental Science, 4th Edition, John Wiley & Sons, USA. 2. Raj Kumar Singh, (2012), Environmental Studies, Tata McGraw Hill Education Private Limited, New Delhi, India. 3. George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.		

Recommended by Board of Studies	14-02-2022		
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 - Stealing - Malpractices in Examinations - Plagiarism.

Module:7 | Abuse of Technologies

Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking 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 Presupposition 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
Approved 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

Course Code	Course Title	L	T	P	C
BSSC102N	Indian Constitution	0	0	0	2
Pre-requisite	NIL				
		1.			

Course Objectives

This Course is an introduction of Indian Constitution and basic concepts highlighted in this course for understanding the Constitution of India.

Course Outcome

At the end of the course, the student will acquire:

1. A basic understanding of Constitution of India.
2. The ability to understand the contemporary challenges and apply the knowledge gained from the course to current social contemporary legal issues.
3. The understanding of constitutional remedies.

Module:1	Introduction to Indian Constitution	5 hours

Introduction to the constitution of India and the Preamble - Sources of Indian Constitution - Features of Indian Constitution - Citizenship - Fundamental Rights and Duties - Directive Principles of state policy

Module:2	Union Government and its Administration Structure of the Indian Union	8 hours

Federalism, Centre- State relationship - President: Role, Power and Position - Prime Minister and Council of ministers - Cabinet and Central Secretariat - Lok Sabha - Rajya Sabha- The Supreme Court and High Court: Powers and Functions

Module:3	State Government and its Administration	4 hours

Governor- Role and Position - Chief Minister and Council of Ministers - State Legislative Assembly - State secretariat: Organization, Structure and Functions

Module:4	Local Administration	7 hours

District's Administration Head- Role and Importance - Municipalities: Introduction, Mayor and role of Elected Representative - Panchayati Raj: Composition and Functions Evolution and 73rd and 74th Amendments - Zila Parishad and district administration: Composition and Functions Elected officials and their roles, CEO Zila Panchayat: Position and role- Panchayat Samiti: Composition and Functions - Gram Panchayat: Composition and Functions Importance of grass root democracy

Module:5	Election Commission	6 hours

Role of Chief Election Commissioner - State Election Commission - Functions of Commissions for the welfare of SC/ST/OBC and women.

	Total Lecture hours:	30 hours

Reference Books				
1.	Durga Das Basu, Introduction to the Constitution of India, Gurgaon; LexisNexis, 2018 (23rd edn.)			
2.	M.V.Pylee, India's Constitution, New Delhi; S. Chand Pub., 2017 (16th edn.)			
3.	J.C Johari, Indian Government and Politics, Shoban Lal & Co., 2012			
4.	Noorani, A.G , Challenges to Civil Rights Guarantees in India, Oxford University Press 2012.			
5.	R. Bhargava, (2008) 'Introduction: Outline of a Political Theory of the Indian Constitution', in R. Bhargava (ed.) Politics and Ethics of the Indian Constitution, New Delhi: Oxford University Press.			
6.	Bidyut Chakrabarty & Rajendra Kumar Pandey, Indian Government and Politics, SAGE, New Delhi, 2008			
7.	G. Austin, The Indian Constitution: CornerStone of a Nation, Oxford, Oxford University Press, 1966			
Mode of Evaluation: CAT, Written assignment, Quiz and FAT				
Recommended by Board of Studies		27-10-2021		
Approved by Academic Council		No. 68	Date	19-08-2022