VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRICAL ENGINEERING

B. Tech Electronics and Instrumentation Engineering

(B.Tech EIE)

Curriculum

(*2022-2023 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

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

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

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

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

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

VISION STATEMENT OF THE SCHOOL OF ELECTRICAL ENGINEERING

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

MISSION STATEMENT OF THE SCHOOL OF ELECTRICAL ENGINEERING

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

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

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

B. Tech Electronics and Instrumentation Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

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

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

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

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

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

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

B. Tech Electronics and Instrumentation Engineering

PROGRAMME OUTCOMES (POs)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

B. Tech Electronics and Instrumentation Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

- PSO1: Design and develop electronics and instrumentation systems for fulfilling socio-economic and environmental requirements.
- PSO2: Analyze and design signal conditioning circuits for sensors, measurement, instrumentation system, process control and automation techniques by considering economic and environmental constraints.
- PSO3: Apply and implement intelligent systems using modern tools for instrumentation engineering.

CREDIT INFO		
S.no	**Catagory**	**Credit**
1	Foundation Core	53
2	Foundation Core - Non Graded	2
3	Discipline-linked Engineering Sciences	10
4	Discipline Core	49
5	Discipline Elective	15
6	Projects and Internship	9
7	Open Elective	15
8	Non-graded Core Requirement	11
Total Credits		151

Foundation Core								
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**Credit**
1	BCHY101L	Engineering Chemistry	Theory Only	1.0	3	0	0	3.0
2	BCHY101P	Engineering Chemistry Lab	Lab Only	1.0	0	0	2	1.0
3	BCSE101E	Computer Programming: Python	Embedded Theory and Lab	1.0	1	0	4	3.0
4	BCSE103E	Computer Programming: Java	Embedded Theory and Lab	1.0	1	0	4	3.0
5	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**	**C**
1	BEEE201L	Electronic Materials	Theory Only	1.0	3	0	0	3.0
2	BEEE202L	Electromagnetic Theory	Theory Only	1.0	2	1	0	3.0
3	BEEE203L	Circuit Theory	Theory Only	1.0	3	1	0	4.0

Discipline Core								
sl.no	**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	BEEE208L	Analog Electronics	Theory Only	1.0	3	0	0	3.0
7	BEEE208P	Analog Electronics Lab	Lab Only	1.0	0	0	2	1.0
8	BEEE302L	Digital Signal Processing	Theory Only	1.0	3	0	0	3.0
9	BEEE302P	Digital Signal Processing Lab	Lab Only	1.0	0	0	2	1.0
10	BEEE303L	Control Systems	Theory Only	1.0	3	0	0	3.0
11	BEEE303P	Control Systems Lab	Lab Only	1.0	0	0	2	1.0
12	BEEE308L	Communication Systems	Theory Only	1.0	3	0	0	3.0
13	BEEE309L	Microprocessors and Microcontrollers	Theory Only	1.0	3	0	0	3.0
14	BEEE309P	Microprocessors and Microcontrollers Lab	Lab Only	1.0	0	0	2	1.0
15	BEIE201L	Sensors and Signal Conditioning	Theory Only	1.0	3	0	0	3.0
16	BEIE201P	Sensors and Signal Conditioning Lab	Lab Only	1.0	0	0	2	1.0
17	BEIE301L	Biomedical Instrumentation	Theory Only	1.0	3	0	0	3.0
18	BEIE302L	Electrical and Electronics Measurement	Theory Only	1.0	3	0	0	3.0
19	BEIE302P	Electrical and Electronics Measurement Lab	Lab Only	1.0	0	0	2	1.0
20	BEIE303P	Process Dynamics and Control Lab	Lab Only	1.0	0	0	2	1.0
21	BEIE303L	Process Dynamics and Control	Theory Only	1.0	3	0	0	3.0
22	BEIE304L	Industrial Instrumentation	Theory Only	1.0	3	0	0	3.0
23	BEIE305L	Industrial Automation	Theory Only	1.0	3	0	0	3.0
24	BEIE305P	Industrial Automation Lab	Lab Only	1.0	0	0	2	1.0
25	BEIE403L	Virtual Instrumentation	Theory Only	1.0	1	0	0	1.0
26	BEIE403P	Virtual Instrumentation Lab	Lab Only	1.0	0	0	2	1.0

Discipline Elective								
sl.no	**Course Code**	**Course Title**	**Course Type**	**Ver**	**L**	**T**	**P**	**C**
1	BEEE001L	Machine Learning	Theory Only	1.0	3	0	0	3.0
2	BEEE002L	Artificial Intelligence	Theory Only	1.0	3	0	0	3.0
3	BEEE004E	VLSI Design	Embedded Theory and Lab	1.0	2	0	2	3.0
4	BEEE005L	Engineering Optimization	Theory Only	1.0	2	1	0	3.0
5	BEEE006L	Embedded Systems Design	Theory Only	1.0	3	0	0	3.0
6	BEEE007L	Digital Image Processing	Theory Only	1.0	3	0	0	3.0
7	BEEE017L	Reliability Engineering	Theory Only	1.0	3	0	0	3.0
8	BEEE018L	Robotics and Control	Theory Only	1.0	3	0	0	3.0
9	BEIE001L	Analytical Instrumentation	Theory Only	1.0	3	0	0	3.0
10	BEIE002L	Micro-Electromechanical Systems	Theory Only	1.0	3	0	0	3.0
11	BEIE003L	Optical Instrumentation	Theory Only	1.0	3	0	0	3.0
12	BEIE004E	Testing and Calibration	Embedded Theory and Lab	1.0	2	0	2	3.0
13	BEIE005L	Non-Destructive Testing	Theory Only	1.0	3	0	0	3.0
14	BEIE006L	Data Communication Networks	Theory Only	1.0	3	0	0	3.0
15	BEIE007E	Automated Test Engineering	Embedded Theory and Lab	1.0	2	0	2	3.0
16	BEIE009L	Computer Architecture and Organization	Theory Only	1.0	3	0	0	3.0
17	BEIE391J	Technical Answers to Real Problems Project	Project	1.0	0	0	0	3.0
18	BEIE392J	Design Project	Project	1.0	0	0	0	3.0
19	BEIE393J	Laboratory Project	Project	1.0	0	0	0	3.0
20	BEIE394J	Product Development Project	Project	1.0	0	0	0	3.0
21	BEIE395J	Computer Project	Project	1.0	0	0	0	3.0
22	BEIE396J	Reading Course	Project	1.0	0	0	0	3.0
23	BEIE397J	Special Project	Project	1.0	0	0	0	3.0
24	BEIE398J	Simulation Project	Project	1.0	0	0	0	3.0

Projects and Internship								
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**Credit**
1	BEIE399J	Summer Industrial Internship	Project	1.0	0	0	0	1.0
2	BEIE497J	Project – I	Project	1.0	0	0	0	3.0
3	BEIE498J	Project - II / Internship	Project	1.0	0	0	0	5.0
4	BEIE499J	One Semester Internship	Project	1.0	0	0	0	14.0

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

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

Course Objectives

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

Course Outcomes :

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

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

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

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

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

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

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

Module:4 Energy devices **6 hours**

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

Module:5 Functional materials **7 hours**

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

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

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

Module:7 Industrial applications **7 hours**

Water purification methods - zeolites, ion-exchange resins and reverse osmosis; Fuels and combustion -LCV, HCV, Bomb calorimeter (numericals), anti-knocking agents); Protective coatings for corrosion control: cathodic and anodic protection - PVD technique; Chemical sensors for environmental monitoring - gas sensors; Overview of computational methodologies: energy minimization and conformational analysis.	
Module:8 Contemporary topics	**2 hours**
Guest lectures from Industry and, Research and Development Orqanizations	
Total Lecture hours:	**45 hours**
Textbook	
1.	Theodore E. Brown, H Eugene, LeMay Bruce E. Bursten, Catherine Murphy, Patrick Woodward, Matthew E. Stoltzfus, Chemistry: The Central Science, 2017, 14th edition, Pearson Publishers, 2017. UK
Reference Books	
1.	Peter Vollhardt, Neil Schore, Organic Chemistry: Structure and Function, 2018, 8th ed. WH Freeman, London
2.	Atkins' Physical Chemistry: International, 2018, Eleventh edition, Oxford University Press; UK
3.	Colin Banwell, Elaine Mccash, Fundamentals for Molecular Spectroscopy, 4th Edition, McGraw Hill, US
4.	Solid State Chemistry and its Applications, Anthony R. West. 2014, 2nd edition, Wiley, **UK.**
5.	AngA"le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic solar energy: From fundamentals to Applications, 2017, Wiley publishers,
6.	**UK.** Lawrence S. Brown and Thomas Holme, Chemistry for engineering students, 2018, 4t^{h} edition - *Open access version*
Mode of Evaluation: CAT, Written assiqnment, Quiz and FAT	
Recommended by Board of Studies	**28.06.2021**
Approved by Academic Council	No.63 Date 23.09.2021

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

Course Objective

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

Course Outcome :

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

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

Indicative Experiments l

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

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

Recommended by Board of Studies l 2s.06.2021

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

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

Course Objectives

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

Course Outcome

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Text Book(s)

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

Reference Books

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

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

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

Course Objectives:

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

Course Outcome:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Total Lecture hours:	**15 hours**

Text Book(s)

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

Reference Books

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

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

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. Evaluate DC and AC circuit parameters using various laws and theorems
2. Comprehend the parameters of magnetic circuits
3. Classify and compare various types of electrical machines and its applications
4. Design basic combinational circuits in digital system
5. Analyze 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

PO's:2,3,4,12 **PSO's:1**	
Recommended by Board of Studies	DD-MM-YYYY
Approved by Academic Council	No. xx

Date	DD-MM-YYYY

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

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			
PO's: 4 **PSO's: 2**			
Recommended by Board of Studies	DD-MM-YYYY		
Approved by Academic Council	No. xx	Date	DD-MM-YYYY

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

Course Objectives:

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

Course Outcomes:

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

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

Text Book(s)

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

Reference Books

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

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

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

Course Objectives:

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

Course Outcomes:

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

Indicative Experiments

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

Total Laboratory Hours I 30 hours

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

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

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

Course Objectives:

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

Course Outcomes:

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

Indicative Experiments

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

Total Laboratory Hours **30 hours**

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

Recommended by Board of Studies | 28.06.2021

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

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Guest lectures from Industry and, Research and Development Orqanizations

Total Lecture hours:	**45 hours**

Text Book

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

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

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

Course Objectives

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

Course Outcomes

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

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

Indicative Experiments

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

Total Laboratory Hours **30 hours**

Text Book

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

Reference Books

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

Mode of assessment: DA and FAT

Recommended by Board of Studies | 24.06.2021

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

BMAT102L	Differential Equations and Transforms	IL IT IP IC
		3 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 Eauations (PDE)	**5 hours**

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

Module:3 Laplace Transform	**7 hours**

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

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

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

Module:5 Fourier Series	**6 hours**

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

Module:6 Fourier Transform	**6 hours**

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

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

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

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

Text Book(s)

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

Reference Books

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

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

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

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

Course Objectives

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

Course Outcomes

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

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

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

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

Text Book(s)

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

Reference Books

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

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

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

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

Course Objectives :

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

Course Outcome :

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Module:7 Reliability — **5 hours**

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

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

Text Book:

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

Reference Books

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

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

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

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

Course Objectives:

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

Course Outcomes:

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

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

Indicative Experiments

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

Text Book

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

Reference Books:

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

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

Recommended by Board of Studies | 24-06-2021

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

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

Course Objectives

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

Course Outcome

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

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

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

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

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

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

Course Objectives

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

Course Outcome

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

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

Indicative Experiments

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

Total Laboratory Hours **30 hours**

Mode of assessment: Continuous assessment/ FAT/ Oral examination

Recommended by Board of Studies 26.06.2021

Approved by Academic Council No. 63 Date 23.09.2021

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

Course Objectives:

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

Course Outcomes:

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

Module:1	Logical Reasoning	5 hours

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

Module:2	Data arrangements and Blood relations	6 hours

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

Module:3	Ratio and Proportion	6 hours

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

Module:4	Percentages, Simple and Compound Interest	6 hours

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

Module:5	Number System	6 hours

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

Module:6	Essential grammar for Placement	7 hours

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

Module:7	Reading Comprehension for Placement	3 hours

Types of questions - Comprehension strateqies - Practice exercises

Module:8	Vocabulary for Placement	6 hours

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

	Total Lecture hours:	45 hours

Text Books)

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

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

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

Course Objectives

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

Course Outcomes

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

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

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

Text Books

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

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

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

Course Objectives

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

Course Outcomes

On completion of this course, the students will be able to:
1. Solve diode circuits for various applications.
2. Analyze and design BJT and MOSFET DC circuits and their amplifier configurations.
3. Interpret frequency response of amplifiers.
4. Identify the impact of negative feedback in amplifier design.

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

Text Book

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

Reference Books

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

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

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

Course Objectives

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

Course Outcomes

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

Indicative Experiments

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

Mode of assessment: Continuous assessment, FAT

Text Book

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

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

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

	Total Lecture hours:	**45 hours**

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

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

Course Objectives

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

Course Outcomes

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

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

Indicative Experiments

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

Mode of assessment: Continuous assessment, FAT

Text Book

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

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

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

Course Objectives

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

Course Outcomes

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

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

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

Text Books

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

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

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

Course Objectives

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

Course Outcomes

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

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

Indicative Experiments

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

Total Laboratory Hours	**30** hours

Text Book

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

Mode of assessment: Continuous assessment, FAT

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

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Design of Wiener and Adaptive filters, applications.

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

	Total Lecture hours:	**45**

Text Books

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

Reference Books

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

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

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

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. Design and perform frequency analysis of continuous time and discrete time signals.
2. Design and implement, digital filters with real time constraints.
3. Design 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

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

Course Objectives

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

Course Outcome

On the completion of this course, the student will be able to:
1. Formulate mathematical models of the physical systems.
2. Analyze the system performance in time and frequency domains.
3. Determine the stability of linear time invariant system in time and frequency domains.
4. Design compensators and controllers to meet the performance specifications.
5. Perform state space analysis and design state feedback control.

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

Text Books

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

Reference Books

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

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

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

Course Objectives

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

Course Outcomes

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

Indicative Experiments

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

Mode of assessment: Continuous assessment, FAT

Text Book

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

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

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Text Books

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

Reference Books

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

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

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

Course Objectives

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

Course Outcomes

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

Indicative Experiments

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

Text Book

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

Reference Book

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

Mode of assessment: Continuous assessment, FAT

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

BEIE201L	Sensors and Signal Conditioning	L	T	P	C
		3	0	0	3
Pre-requisite	**BEEE208L, BEEE208P**	**Syllabus version**			
		1.0			

Course Objectives

1. Comprehend the concepts of measurement systems and classification of transducers.
2. Understand the principles and construction of various sensors and transducers.
3. Familiarize the design of signal conditioning circuits for different sensors.

Course Outcomes

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

1. Understand and comprehend the concepts of transducers, standards and calibration.
2. Apply various types of resistive and reactance variation sensors in real time applications.
3. Interpret the design aspects of signal conditioning circuits for resistive and reactance variation sensors.
4. Analyze the self-generating sensors and associated signal conditioning circuits.
5. Compare various types of electromagnetic, optical and digital sensors.

Module:1	**Basics of measurement system**	**7 hours**

General concepts, terminology and input-output configuration, Classification of transducers, Static and dynamic characteristics, calibration and standards, Errors and statistical analysis, least square fit of experimental data.

Module:2	**Resistive Sensors**	**5 hours**

Strain gauges: Piezo resistive effect, beam, column and ring type force, torque measurement; RTD, Thermistor: models, types, linearization and applications; Magneto resistors, Light dependent resistors.

Module:3	**Reactance Variation Sensors**	**5 hours**

Capacitive sensors: variable, differential; Inductive sensors: variable reluctance, eddy current, LVDT, magnetoelastic and magnetostrictive.

Module:4	**Signal conditioning for resistive sensors**	**5 hours**

Voltage dividers: amplifiers for voltage dividers; Wheatstone bridge: balance measurements, deflection measurements, sensitivity, linearity, analog linearization of resistive sensor bridges; Differential and instrumentation amplifiers, Grounding and isolation.

Module:5	**Signal conditioning for reactance variation sensors**	**5 hours**

AC bridges, Operational amplifier-based inductance and capacitance measuring circuits, Carrier amplifiers and coherent detection, Signal conditioners for capacitive sensors.

Module:6	**Self-generating Sensors and signal conditioning**	**8 hours**

Thermocouple, piezoelectric, pyroelectric and electrochemical sensors: effect, materials, applications; Signal conditioning circuits: chopper, low drift, electrometer, transimpedance and charge amplifiers, noise in amplifiers.

Module:7	**Electromagnetic, Optical and Digital sensors**	**8 hours**

Electromagnetic sensors: sensors based on Faraday's law, Hall effect sensor; Ultrasonic

based sensors; Optical transducer: photo emissive cells, photoconductive cells, photo diodes, photo transistors, photovoltaic cells; Position encoders: absolute position encoder, incremental position encoder; Resonant sensors: sensors based on quartz resonators, digital quartz thermometer, quartz micro balance, quartz resonators for force and pressure sensing, quartz angular rate sensor; SAW sensors.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Books		
1	Ramon Pallas-Areny,John G.Webster, Sensors and Signal Conditioning, 2012, 2nd Edition, Wiley	
2	Sawhney A. K., and Sawhney, Puneet, A Course in Electrical and Electronic Measurements and Instrumentation, 2016, 19th Edition, Dhanpat Rai & Company	
Reference Books		
1	Morris, Alan S., and Langari, Reza, Measurement and Instrumentation: Theory and Application, 2021, 3rd Edition, Academic Press	
2	Dunn, Patrick F., Measurement, Data Analysis, and Sensor Fundamentals for Engineering and Science, 2019, 2nd Edition, CRC Press	
3	Doebelin, E. O., and Manik, D. N., Measurement systems: application and design, 2020, 7th edition, McGraw Hill Education	
4	Murty, D. V. S, Transducers and Instrumentation, 2012, 2nd edition, PHI Learning Pvt. Ltd	
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

BEIE201P	Sensors and Signal Conditioning Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEEE208L, BEEE208P**	**Syllabus version**			
		1.0			

Course Objectives

1. Familiarize the characteristics of various sensors and performance metrics of measurement systems.
2. Apply the inculcated knowledge in design of signal conditioning circuits for different sensors.

Course Outcomes

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

1. Design and conduct experiments to analyze and interpret data.
2. Use the techniques, skills and modern engineering tools necessary for the design of measurement systems.
3. Select suitable sensors or transducers for various industrial and domestic applications.

Indicative Experiments

1.	Temperature measurement system using RTD and thermistor
2.	Strain gauge-based torque measurement system
3.	Temperature measurement system using J and K type thermocouples
4.	Displacement measurement system using LVDT
5.	Displacement measurement using Inductive pickup
6.	Pressure measurement using diaphragm and Bourdon tube pressure gauges
7.	Level measurement using capacitive transducer
8.	Design and develop signal conditioning circuits for Pt100 sensor and NTC thermistor
9.	Design a signal conditioning circuit for thermocouple cold junction compensation using K-type thermocouple
10.	Design and development of signal conditioning circuit for an inductive sensor
11.	Design and development of signal conditioning circuit for a capacitive sensor
12.	Design and development of signal conditioning circuit for self-generating sensor
13.	Data acquisition and Linearisation of transducer output using LabVIEW
	Total Laboratory Hours **30**

Mode of assessment: Continuous assessment, FAT

Text Book

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

Reference Book

1. John G. Webster, Halit Eren, Measurement, Instrumentation, and Sensors Handbook: Two-Volume Set, 2018, 2nd Edition, CRC Press

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

BEIE301L	Biomedical Instrumentation	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand bio-signal characteristics and acquisition of bio-signals.
2. Design and develop diagnostic, therapeutic and clinical equipment.
3. Compare and analyze imaging concepts for medical applications.

Course Outcomes

1. Analyze the physiological signals by applying principles of mathematics.
2. Apply the knowledge to select appropriate diagnostic instruments and advanced techniques.
3. Design and develop therapeutic devices in medical practices.
4. Develop the instruments for clinical applications and analysis.
5. Design a product with all relevant standards and realistic constraints.

Module:1	**Bio Signals**	**7 hours**
Bio signals characteristics: frequency and amplitude ranges; Origin of bio potentials, cell resting potential, action potentials; Electrode-electrolyte interface, electrode-skin interface, half-cell potential, non-polarizable electrodes; Types of electrodes: surface, needle, micro electrodes; Electrodes for ECG, EMG, EEG.		
Module:2	**Bio Signal Amplifiers and Recorders**	**6 hours**
Bio amplifiers: Instrumentation amplifier, isolation amplifier; Recording devices; Bio electric Safety; Codes and standards.		
Module:3	**Diagnostic Equipment**	**8 hours**
Electrophysiology: Electrocardiography (ECG), Einthoven's triangle, ECG lead system; Electroencephalography (EEG), 10-20 electrode system; Electromyography (EMG); Electrooculography (EOG); Blood pressure monitors; Pulse Oximeter; Spirometer.		
Module:4	**Therapeutic Equipment**	**7 hours**
Pacemakers; Defibrillator; Heart lung machine; Nerve and muscle stimulators; Dialyser; Surgical diathermy; Ventilator.		
Module:5	**Clinical Instruments**	**7 hours**
Analysis of Blood: Measurement of pH, pO2, pCO2 gas analysers; Photometers; Hematology; Electrophoresis: Principles and applications; Blood cell counters; Bio sensors: Blood Glucose Sensors; GSR measurements		
Module:6	**Medical imaging techniques**	**8 hours**
Basics of diagnostic Radiology: X-Ray Imaging; Computed Tomography (CT); Magnetic Resonance Imaging (MRI) System; Ultrasonic Imaging Systems; Thermal Imaging; Radiation therapy: Gamma Camera, PET, SPECT.		
Module:7	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1	John G Webster, Amit J Nimunkar, Medical instrumentation: application and design, 2020, 5th Edition, John Wiley & Sons
2	Khandpur, R.S., Handbook of biomedical instrumentation, 2014, 3rd Edition, McGraw-Hill Education

Reference Books

1.	Carr, J.J. and Brown, J.M., Introduction to biomedical equipment technology. 2001, 4th Edition, Pearson College Division.			
2.	Cromwell, L., Weibell, F.J., Pfeiffer, E.A. and Usselman, L.B., Biomedical instrumentation and measurements,1990, Englewood Cliffs, N. J., Prentice-Hall, Inc			
3.	Haidekker, M.A., Medical imaging technology, 2013, Springer			
Mode of Evaluation: CAT, Assignment, Quiz, FAT				
Recommended by Board of Studies		19-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BEIE302L	Electrical and Electronics Measurement	L	T	P	C
		3	0	0	3
Pre-requisite	**BEIE201L, BEIE201P**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand the basics of electrical and electronic measurement systems.
2. Impart the knowledge of measuring instruments, operating principles, limitations.
3. Design of data acquisition systems and Implementation of virtual instrumentation.

Course Outcomes

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

1. Comprehend the concepts and working principle of electrical measuring meters.
2. Design a potentiometer, AC and DC bridges to measure resistance, capacitance and inductance.
3. Design signal generators and understand the working of electronic instruments.
4. Compare and comprehend various signal analyzers.
5. Design and implementation of DAQ system to realize virtual instrumentation.

Module:1	**Electrical Measurement**	**9 hours**

Analog Instruments: PMMC, moving iron, electro dynamometer, rectifier type, and thermal instruments; Power Measurement: ED wattmeter, Single and three-phase power measurement, Hall effect Wattmeter; Energy measurement: energy meter; Magnetic measurements: Ballistic tests; PF meter; High voltage measurements; Q meter.

Module:2	**DC & AC Bridges**	**8 hours**

Series and Shunt type ohmmeter; Megger; DC Bridges: Wheatstone Bridge, Kelvin Bridge; AC Bridges: Maxwell Bridge, Anderson bridge, Hay's bridge, Desauty's bridge, Wien Bridge, Schering Bridge; Transformer ratio Bridges; Wagner Ground connections.

Module:3	**Potentiometers and Instrument transformers**	**6 hours**

DC and AC Potentiometers: Types, Working Principle and applications; Instrument Transformers: CT and VT construction, theory, operation, characteristics.

Module:4	**Electronic Meters**	**8 hours**

Solid State Instruments: BJT, FET and MOSFET Voltmeter circuits, Solid State Multi-meter, Digital Multi-meter; Digital wattmeter; Digital energy meter; Digital LCR meter; Digital Frequency Meter: Direct and indirect counting type; Measurement of period and time; Phase angle measurement; DSO.

Module:5	**Signal Generators and Analyzers**	**6 hours**

Signal Generation: Audio and Radio frequency signal generators, Function generator; Wave analyzer; Spectrum analyser.

Module:6	**Data Acquisition & Virtual Instrumentation**	**6 hours**

Elements of digital data acquisition system; A/D converters: Types, resolution, dynamic range, accuracy, sampling concepts and techniques, A/D boards; D/A converters: Types, D/A boards; Digital I/O boards; Counter/Timer I/O boards; Data logger; Virtual Instrumentation: Data Acquisition with LabVIEW.

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

	Total Lecture hours:	**45 hours**

Text Books

1. Shawney A. K., A course in Electrical and Electronic Measurements and Instrumentation, 2016, 19th Edition, Dhanpat Rai and Sons

2.	Gary W. Johnson, Richard Jennings, LabVIEW Graphical Programming, 2017, 4th Edition, McGraw Hill Education
Reference Books	
1.	David A. Bell, Electronic Instrumentation and Measurements, 2013, 3rd Edition, Oxford university press
2.	E. W. Golding, F. C. Widdis, Electrical Measurements and Measuring Instruments, 2019, 6th Edition, Medtech
3.	Cooper W. D. and Helfrick A. D., Modern Electronic Instrumentation and Measurement Techniques, 2015, 4th Edition, Pearson India Education
4.	H. S. Kalsi, Electronic Instrumentation and Measurements,2019, 4th Edition, 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

BEIE302P	Electrical and Electronics Measurement Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEIE201L, BEIE201P**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand of electrical and electronic measurement systems.
2. Design of data acquisition systems and virtual instrumentation.

Course Outcomes

On successful completion of this course the student will

1. Design DC and AC bridges to measure resistance, inductance and capacitance.
2. Calibrate voltmeter, ammeter, wattmeter and energy meter.
3. Develop LabVIEW program to acquire real world signal with realistic constraints.

Indicative Experiments

1.	Design a bridge circuit to measure resistance in low and medium ranges
2.	Design a circuit to measure high values of current and voltage using low range meters
3.	Design of inductance measurement bridge circuit
4.	Design of capacitance measurement bridge circuit
5.	Calibrate single phase energy meter at unity power factor
6.	Calibrate single phase electro dynamometer type wattmeter with direct loading
7.	Measurement of insulation resistance using Megger
8.	Build a Virtual Instrument (VI) to acquire and process real time signals using NI DAQ cards
9.	Develop a VI to read LVDT output voltage using USB 6221
10.	Build a VI diagram using formula node in case structure palette
11.	Develop a VI to activate an alarm for a pre-set value
12.	Develop a VI to monitor the liquid level
	Total Laboratory Hours **30 hours**

Text Book

1. Shawney A. K., A course in Electrical and Electronic Measurements and Instrumentation, 2016, 19th Edition, Dhanpat Rai and Sons

Reference Book

1. Gary W. Johnson, Richard Jennings, LabVIEW Graphical Programming, 2017, 4th Edition, McGraw Hill 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

BEIE303L	Process Dynamics and Control	L	T	P	C
		3	0	0	3
Pre-requisite	**BEIE201L, BEIE201P, BEEE303L, BEEE303P**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand the process dynamics through mathematical modelling.
2. Solving control and instrumentation problems for continuous or batch processes.
3. Identify suitable advanced control strategies for industrial processes.

Course Outcomes

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

1. Develop mathematical model of various physical processes using first principles.
2. Analyze the characteristics of various control actions and controller tuning methods.
3. Analyze the control valve characteristics and valve sizing.
4. Design and implement various advanced control schemes for industrial processes.
5. Develop a control strategy for a process involving multiple variables and constraints.

Module:1	**Process Dynamics**	**9 hours**

Need for process control; Mathematical model of Processes; Interacting and non-interacting systems; Self-regulation; Continuous and batch processes; Lumped and distributed parameter models; Degrees of freedom; Servo and regulatory operations; Linearization; Piping and Instrumentation Diagram (P&ID) of control loops.

Module:2	**Controller Actions**	**5 hours**

Characteristic of controllers: ON-OFF, proportional, integral, derivative, P+I, P+D and P+I+D modes; Practical forms of PID Controller; PID Implementation issues; Bumpless transfer; Reset windup; Derivative kick; Selection of control modes for different processes.

Module:3	**PID controller Tuning**	**6 hours**

Evaluation criteria: IAE, ISE, ITAE, quarter decay ratio; Tuning Methods: Process reaction curve (Cohen-Coon), Ziegler-Nichols method, damped oscillation method, Auto tuning; Digital PID controller: Position, velocity form.

Module:4	**Final Control Elements**	**8 hours**

Final control elements: I/P converter, Pneumatic and electric actuators, Control valve terminology; Characteristic of Control Valves: Inherent, Installed; Valve positioner; Valve body; Commercial valve bodies; Control valve sizing; ISA S 75.01 standard flow equations for sizing Control Valves; Cavitation and flashing; Valve selection criteria.

Module:5	**Control Loop Enhancement**	**4 hours**

Cascade control; Feed-forward control; Ratio control; Inferential control; Split-range; Adaptive Control.

Module:6	**Model-Based Control Schemes**	**7 hours**

Smith Predictor Control Scheme; Internal Model Controller: IMC PID controller, predictive controller, MPC schemes; Multi-loop control schemes.

Module:7	**Case Studies**	**4 hours**

Distillation column: Control of top and bottom product compositions, reflux ratio; Control of chemical reactor; Control of heat exchanger; Steam boiler-drum level control and combustion control; Complete air–supply system for pneumatic control equipment; pH control.

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

Text Books

1.	George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, 2017, Prentice-Hall
2.	Coughanowr, D.R., Process Systems Analysis and Control, 2017, 3rd edition, McGraw Hill Education
Reference Books	
1.	Curtis D. Johnson, Process Control Instrumentation Technology, 2015, 8th edition, Pearson Education
2.	Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, Francis J. Doyle III, Process Dynamics and Control, 2017, 4th edition, John Wiley & Sons
3.	Bela G. Liptak, Instrument Engineers Handbook, Volume 2: Process Control and Optimization, 2018, 4th edition, CRC Press
Mode of Evaluation: CAT, Written Assignment, Quiz, FAT	

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

BEIE303P	Process Dynamics and Control Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BEIE201L, BEIE201P, BEEE303L, BEEE303P**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand the practical implementation of various control strategies for real-time processes.
2. Design of Cascade, Ratio, Feed-forward control schemes.

Course Outcomes

1. Design suitable control schemes for industrial processes.
2. Implementation of advanced control strategies for industrial processes.

Indicative Experiments

1.	Identify the dynamics of first order, second order, interacting and non-interacting processes
2.	Experimental study of PID controller on level process station
3.	Modeling and control of pressure process station
4.	Experimental study of ON-OFF and PID controller on temperature process
5.	Analysis of inherent and installed characteristics of control valves
6.	Experimental study of cascade / ratio control for a level-flow process
7.	Performance comparison of PID controller tuning methods using MATLAB
8.	Simulation of nonlinear processes using MATLAB
9.	Design and implementation of dead time compensator using MATLAB
10	Performance comparison of single and multi-loop controllers
11.	Design and implementation of velocity and position form of PID Control algorithms using MATLAB
12.	Disturbance rejection assessment of IMC-PI controller
	Total Laboratory Hours | 30 hours

Text Book

1.	George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, 2017, Prentice-Hall

Reference Book

1.	Bela G. Liptak, Instrument Engineers Handbook, Volume 2: Process Control and Optimization, 2018, 4th edition, CRC Press

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

BEIE304L	Industrial Instrumentation	L	T	P	C
		3	0	0	3
Pre-requisite	**BEIE201L, BEIE201P**	**Syllabus version**			
		1.0			

Course Objectives

1. Comprehend various industrial instruments to enable continuous monitoring of process parameters.
2. Design of industrial sensors and supporting systems.
3. Apply smart instrumentation methods to monitor the industrial parameters.

Course Outcomes

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

1. Understand the physics and methodology for various measuring systems.
2. Design and technically evaluate industrial measuring techniques.
3. Identify the suitable sensors and supporting systems for industrial applications.
4. Formulate responses to solve the measurement related problems in an industrial environment.
5. Demonstrate standard tools and techniques pertaining to solve Industry 4.0 applications.

Module:1	**Pressure Measurement**	**6 hours**
Units and Terminologies; Measurement: manometer, elastic type, electrical type: capacitive, piezo resistive; Vacuum measuring; Application Considerations: selection, installation, calibration.		
Module:2	**Level Measurement**	**5 hours**
Units and Terminologies; Direct measurement: sight glass, float; Indirect measurement: differential pressure type, capacitive type, radar type, ultrasonic type; application considerations: selection, installation, calibration.		
Module:3	**Temperature Measurement**	**5 hours**
Units and Terminologies; Measurement: thermometers, resistive type, thermocouples, radiation type, optical type, semiconductor type; Application considerations: selection, installation, calibration.		
Module:4	**Flow Measurement**	**6 hours**
Units and Terminologies; Measurement: positive displacement type, rotameter, turbine type; Electrical type: electromagnetic, ultrasonic, laser doppler; Solid flow measurement; Open channel flow measurement; Application considerations: selection, installation, calibration.		
Module:5	**Speed, Vibration and Force Measurement**	**7 hours**
Speed measurement: units, revolution counter, tacho generators; Vibration Measurement: units, seismic transducer; Accelerometers: potentiometric, piezo electric; Force measurement: units, hydraulic, pneumatic.		
Module:6	**Viscosity, Humidity, Density and Moisture Measurement**	**7 hours**
Viscosity Terminologies; Viscometer; Humidity terminologies; Psychrometers; Dew cell; Electrolysis hygrometer; Capacitive humidity sensor; Density measurement: Weight and buoyancy; Moisture measurement: electrical methods, weight measurement techniques.		
Module:7	**Smart Sensors and Industry 4.0**	**7 hours**
Sensor connectivity and protocols; Sensor standards; Use cases: predictive maintenance, asset monitoring, safety and alarms; VLSI and MEMS based sensors; AI based sensors.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1.	Dunn, William C., Fundamentals of industrial instrumentation and process control, 2018, 2nd edition, McGraw-Hill Education, New York
2.	D. Patranabis, Principles of Industrial Instrumentation, 2013, 3rd edition, Tata McGraw Hill Education, New Delhi
Reference Books	
1.	Morris, Alan S., and Reza Langari, Measurement and instrumentation: theory and application, 2021, 3rd edition, Academic Press, London
2.	Nakra, B. C., and K. K. Chaudhry, Instrumentation, measurement and analysis, 2017, 4th edition, Tata McGraw-Hill Education, New Delhi
3.	Bhuyan, Manabendra., Intelligent instrumentation: principles and applications, 2017, CRC Press, Florida

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

BEIE305L	Industrial Automation	L	T	P	C
		3	0	0	3
Pre-requisite	**BEIE201L, BEIE201P, BEEE303L, BEEE303P**	**Syllabus version**			
		1.0			

Course Objectives

1. Provide insights into the concepts of automation in process industries.
2. Impart the knowledge on application of PLC, SCADA and DCS in industrial automation.
3. Understand various communication protocols used in process automation industries.

Course Outcomes

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

1. Identify different components of the automation system.
2. Develop PLC program for the industrial application.
3. Configure DCS to handle local and distributed automation task.
4. Develop SCADA for monitoring the industrial application.
5. Propose proper industrial network protocol for industrial multilayer automation.

Module:1	**Concepts of Industrial Automation**	**6 hours**

Industrial Automation: need and benefits of industrial automation, role of automation in industries, automation pyramid; Types of Automation systems: fixed, programmable, flexible; Automation tools; Automation strategy evolution; Control system audit; performance criteria; Safety Systems.

Module:2	**PLC Fundamentals**	**5 hours**

Architecture of PLC; Need of PLC for industrial automation; Memory structure of PLC; Building blocks of PLC: CPU, memory organization, input-output modules (discrete and analog), Special I/O modules, power supply, fixed and modular PLC, redundancy in PLC module, I/O module selection criteria and interfacing.

Module:3	**PLC Programming and Applications**	**9 hours**

PLC I/O addressing; PLC programming instructions; Relay type instructions; Timer instructions: on-delay, off-delay, retentive, pulse; Counter instructions: up, down; comparison instructions, data handling instructions, arithmetic instructions; PLC programming language: functional block diagram, instruction list, structured text, sequential function chart, ladder programming; PLC based applications: motor sequence control, traffic light control, elevator control, tank level control, conveyor system, stepper motor control, reactor control.

Module:4	**Distributed Control Systems**	**6 hours**

DCS: architecture, selection; Local Control Unit: configurations, languages, process interfacing issues; communication facilities; Functions of DCS: database management, reporting, alarm management, communication, third party interface, control, and display.

Case studies in DCS: advanced process control, batch application, data management, security, and access control.

Module:5	**Supervisory Control and Data Acquisition System**	**6 hours**

SCADA: architecture, benefits; Interfacing SCADA system with PLC: connection diagram, object linking and embedding for process control, creating SCADA screen, linking SCADA

object with PLC ladder program; Applications of SCADA: traffic light control, water distribution, pipeline control.		
Module:6	**Instrumentation Standard Protocols**	**6 hours**
Open System Interconnection (OSI) model; Communication standards: RS232, RS485, Modbus; Third party interface; Concept of OPC-UA; Industrial Protocols: HART, Foundation Fieldbus, DeviceNet, Profibus, ControlNet, Industrial Ethernet.		
Module:7	**Case Studies on Automation in Various Industries**	**5 hours**
Industry 4.0; Automation: power plant, water resource management, wastewater treatment, food and beverages, cement, pharmaceuticals, automobile and building management system.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1.	Stamatios Manesis, George Nikolakopoulos, Introduction to Industrial Automation, 2018, CRC Press
2.	Frank D. Petruzella, Programmable Logic Controllers, 2016, 5th edition, McGraw- Hill, New York
Reference Books	
1.	R.G. Jamkar, Industrial Automation Using PLC SCADA & DCS, 2018, Global Education Limited
2.	P Michael Lukas, Distributed Control Systems: Their Evaluation and Design, 2016, Van Nostrand Reinhold Co., New York
3.	Richard Zurawski, Industrial Communication Technology Handbook, 2017, 2nd edition, 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

BEIE305P	**Industrial Automation Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Pre-requisite	**BEIE201L, BEIE201P, BEEE303L, BEEE303P**	**Syllabus version**			
		1.0			

Course Objectives

3. Familiarize with PLC programming and implementation of ladder logic for automation.
4. Configure PID control block to achieve closed loop control using DCS.

Course Outcomes

1. Design and develop PLC program for industrial applications.
2. Configure and develop feedback control schemes using PLC.
3. Configure HMI to interface with PLC.

Indicative Experiments

1.	Experimental study of timer and counter instructions in PLC
2.	Implementation of sequential control using PLC sequencer function
3.	Develop a ladder logic program for traffic light control system.
4.	Develop a ladder logic program for automated elevated control.
5.	Experimental study of analog and digital I/O interfacing in PLC
6.	Controlling a pick and place robotic arm using PLC
7.	Controlling a gantry crane using PLC
8.	Controlling a material handling conveyor
9.	Controlling a 3-axis positioner
10.	HMI module interface and coding with PLC for pick and place robotic arm, material handling
11.	PID control implementation using PLC
12.	Case study of DCS: Level controller
	Total Laboratory Hours **30 hours**

Text Book

1.	Frank D. Petruzella, Programmable Logic Controllers, 2016, 5th edition, McGraw- Hill, New York

Reference Book

2.	Stamatios Manesis, George Nikolakopoulos, Introduction to Industrial Automation, 2018, CRC 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

Course code	Virtual Instrumentation	L	T	P	C
BEIE403L		1	0	0	1
Pre-requisite	BEIE201L, Sensors and Signal Conditioning			Syllabus version	

Course Objectives

1. Familiarize with the Graphical programming environment in Virtual Instrumentation
2. Acquire knowledge on data acquisition systems and interfacing concepts
3. Understand various analysis tools and develop virtual instruments for various applications

Course Outcomes

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

1. Apply the various tools in graphical programming for Virtual Instrument
2. Design a virtual interface using graphical programming
3. Develop systems for real-time signal acquisition and analysis
4. Implement and design data acquisition systems for practical applications
5. Suggest solutions for automation and control applications using virtual instrumentation

Module:1	Elements of Virtual Instrument	2 hours

Conventional instruments; Virtual Instruments: Functional description of a digital instrument, block diagram, hardware and software, user interfaces; advantages of virtual instrumentation over conventional instruments

Module:2	Graphical Programming Control Structures	3 hours

Graphical programming techniques; VIs and sub-VIs; Data flow programming: modular programming, Loops, local and global variables, Case and sequence structures, types of data Arrays; Formula nodes: String and file I/O

Module:3	Data Acquisition (DAQ)	3 hours

PC-based DAQ system: PC, transducers and signal conditioners, DAQ hardware; Data acquisition specifications; Real-Time system integration; Set up for data acquisition universal DAQ card

Module:4	Cluster of Instruments in Interfacing Systems	2 hours

Interfacing of external instruments to a PC: RS 232C, RS 422, RS 485, USB standards and IEEE 488 standard; Protocols: MOD bus and CAN bus

Module:5	Real Time controller design	3 hours

Real time controller design using Virtual Instrumentation software: ON/OFF controller, PID controller; Modelling and basic control of level and reactor processes; Case studies: Temperature indication and monitoring, VI based motor speed controller

Module:6	Contemporary Issues	2 hours

Guest lecture by experts of Industry and R & D Organizations

	Total Lecture hours:	15

Text Books

1	Sanjay Gupta, Joseph John, “Virtual Instrumentation using LabVIEW”, Tata McGraw Hill, New Delhi, 2010
2	Jovitha Jerome, “Virtual Instrumentation using LabVIEW”, PHI Learning Pvt. Ltd, New Delhi, 2012

Reference Books			
1.	Ian Fairweather, Anne Brumfield, "LabVIEW: A Developer's Guide to Real World Integration", CRC Press, 2012		
2.	Richard Jennings, "LabVIEW Graphical Programming", 5th edition, McGraw Hill, New York, 2020		
3.	Parab, J. S., Nazareth, I. A., Gad, R. S., & Naik, G, "Learning by Doing with National Instruments Development Boards" CRC Press, 2020		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
PO's: 1,2,3,5 **PSO's: 1, 2**			
Recommended by Board of Studies	DD-MM-YYYY		
Approved by Academic Council	No. xx	Date	DD-MM-YYYY

Course code	**Virtual Instrumentation Lab**	**L**	**T**	**P**	**C**

BEIE403P		0	0	2	1
Pre-requisite	**BEIE201L , Sensors and Signal Conditioning**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. Familiarize the characteristics of various sensors and performance metrics of measurement systems
2. Apply the inculcated knowledge in design of signal conditioning circuits for different sensors

Course Outcomes

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

1. Analyse the analog and digital signals acquired from devices
2. Design a component or a product applying all the relevant standards with realistic constraints
3. Apply modern engineering tools necessary for the design of measurement systems

Indicative Experiments

1.	Creating Virtual Instrumentation for simple arithmetic and logical applications
2.	Programming Exercises for Clusters and Graphs
3.	Programming Exercises for Loops and Charts
4.	Programming exercises on case and sequence structures, file Input / Output
5.	Sensor linearization using curve fitting, interpolation methods
6.	Swing-up and Balance of rotary pendulum using NI ELVIS and LabVIEW
7.	Speed and Position control of DC motor using NI ELVIS and LabVIEW
8.	Real time temperature control using Virtual Instrumentation.
9.	Real time sequential control of bottle filling system
10.	Reactor control using Virtual Instrumentation environment
11.	Water level controller using Virtual Instrumentation environment
12.	Controlling motor speed through voice using Virtual Instrumentation software
13.	Monitoring and controlling of soil humidity

Total Laboratory Hours	**30**

Text Book

Jovitha Jerome, "Virtual Instrumentation using LabVIEW", PHI Learning Pvt. Ltd, New Delhi, 2012

Reference Book

Richard Jennings, "LabVIEW Graphical Programming", 5th edition, McGraw Hill, New York, 2020

Mode of assessment: Continuous assessment, FAT

PO's: 1, 2, 3, 5
PSO's: 1, 2

Recommended by Board of Studies	DD-MM-YYYY		
Approved by Academic Council	No. xx	Date	DD-MM-YYYY

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

Course Objectives

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

Course Outcomes

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

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

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

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

Module:2 Semiconductor Materials — **10 hours**

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

Module:3 Magnetic Materials — **6 hours**

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

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

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

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

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

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

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Course Objectives

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

Course Outcomes

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

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

Module:1	Network Topology	6 hours

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

Module:2	Network Theorems	10 hours

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

Module:3	Three-phase Systems	8 hours

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

Module:4	Analysis of Transient Response of Circuits	10 hours

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

Module:5	Network Function and Frequency Response	10 hours

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

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

Module:6	Fourier Analysis and Its Applications	7 hours

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

Module:7	Two Port Networks	7 hours

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

Module:8	Contemporary Issues	2 hours

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

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

Course Objectives

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

Course Outcomes

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

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

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

List of Challenging Experiments (Indicative)

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

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

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

Course Objectives

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

Course Outcomes

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

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

Module:1	Classical Optimization Basics	7 hours

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

Module:2	One-Dimentional search methods	5 hours

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

Module:3	Gradient based optimization	7 hours

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

Module:4	Conjugate Direction Methods	7 hours

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

Module:5	Dynamic Optimization	6 hours

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

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

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

Module:7	Gradient-free Optimization	6 hours

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

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	45 hours

Text Book

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

Reference Books

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

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Text Books

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

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

Course Code	Course Title	L	T	P	C
BEEE408L	Reliability Engineering	3	0	0	3
Pre-requisite	BMAT202L, BMAT202P	Syllabus version			
		1.0			

Course Objectives

1. Create awareness on principles & methods of reliability and safety engineering tools and techniques
2. Comprehend the importance of reliability and its relationship with quality and safety
3. Analyze the factors that influence a system's reliability

Course Outcomes

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

1. Examine the system's reliability requirements and assign sub-systems to them.
2. Construct models to analyze and predict reliability performance using block diagrams
3. Evaluate a design's ability to achieve its reliability and safety goals
4. Recognize the various reliability test methodologies and choose the appropriate one for assessing, demonstrating, or increasing reliability
5. Analyze how manufacturing variability affects system reliability

Module: 1	Reliability Fundamentals	6 hours

Reliability, Availability, Maintainability, Safety (RAMS), Benefits of Reliability Engineering, Bathtub Curve, Interrelationship between RAMS and quality; Product Life Cycle: Phases and applicable RAMS activities; Reliability Engineer: Role and responsibilities; Ethics in reliability engineering

Module: 2	Probability and Statistics for Reliability	6 hours

Statistics and probability concepts: Probability distributions, Probability functions; Sampling plans: Statistics and Reliability Testing, Confidence intervals; Weibull Analysis

Module: 3	Reliability and Safety in Design	6 hours

Reliability Requirements: Allocation, Reliability Modelling, Life Estimation, Part and Assembly Reliability Considerations; Reliability Analysis Techniques: FMEA, Fault Tree Analysis, Worst Case Analysis, Durability Analysis

Module: 4	Reliability Testing	9 hours

Reliability Testing Strategies: Introduction, Design of Experiments, Combinatorial Testing, HALT, RGT, ALT, Fracas and Root Cause Analysis; Sample Size and Test Duration: Guidelines, Weibull distribution, Sample size calculation, Life data Analysis

Module: 5	RAMS – AERO & MEDICAL	6 hours

RAMS in Aerospace Domain: ARP 4761 and ARP 4754, System Safety Assessment Process; Introduction: DO-178, DO-254 and DO-160E Standards; Process FMEA, MSG 3 Analysis; RAMS Case Study on Aero Program
RAMS in Medical Domain: Medical Devices, Classification and Applicable Reliability and Risk Management Tasks, Standards: ISO 14971, ISO 13485; Post Market Surveillance (PMS) in Medical Devices; RAMS Case Study on Medical Devices

Module: 6	RAMS – AUTO & INDUSTRIALS	6 hours

RAMS in Auto Domain: DFR Process in Auto Domain, ISO 26262, Functional Safety, ITAF 16949 Standard, Warranty Data Management; RAMS Case Study on Auto Systems
RAMS in Industrial Domain: IEC 61508, Functional Safety Standard; RAMS Case Study on Industrial Systems

Module: 7	RAMS - Appliances, Office Automation Products, Consumer	4 hours

	Electronics	
RAMS in Appliances, Case Study: Office Automation Product and Consumer Electronics		
Module: 8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours	**45 hours**

Text Book

1.	C. Ebeling, "An Introduction to Reliability and Maintainability Engineering", 3rd edition, Waveland Press, Inc., 2019
2.	CRE Primer – The Reliability Engineer solution Text, Quality Council of Indiana, USA, 2018

Reference Books

1.	Roy Billinton and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", 2nd edition, 4th reprint, Springer India Publications, 2013
2.	O'Connor, Patrick, and Andre Kleyner, "Practical reliability engineering", 5th edition, John Wiley & Sons, 2015
3	Andrew K.S. Jardine, Albert H.C. Tsang, Maintenance, Replacement, and Reliability: Theory and Applications, Second Edition - CRC Press – Taylor & Francis, 2013

Mode of Evaluation: CAT, Quiz, Assignments, FAT

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

Course Code	Course Title	L	T	P	C
BEEE409L	Robotics and Control	3	0	0	3
Pre-requisite	BEEE303L, BEEE303P	Syllabus version			
		1.0			

Course Objectives

1. Impart knowledge on the kinematics and dynamics of the manipulator
2. Develop a controller for tracking a desired trajectory and path planning by a robot
3. Design machine vision system in robotic motion control

Course Outcome

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

1. Understand the forward and inverse kinematic of robot manipulators
2. Develop the dynamics of the robotic manipulator using Euler Lagrangian approach
3. Demonstrate an ability to generate joint trajectories for motion planning
4. Implement the multivariable controller for setpoint tracking and disturbance rejection
5. Apply machine vision system in robotic motion control

Module:1	**Robots**	**3 hours**
Types of robots; Degrees of freedom; Robot configurations and concept of workspace, End effectors; Different types of grippers: vacuum and other methods of gripping; Pneumatic, hydraulic and electrical actuators; Specifications of industrial robots		
Module:2	**Kinematics of Robot Manipulator**	**8 hours**
Coordinate frames, Rotation matrix, Inverse transformations, Composite rotation matrix, Homogenous transformations; Robotic manipulator joint co-ordinate system; Euler Angle & Euler transformations, Roll Pitch Yaw (RPY) transformation, Axis/angle transformation, D-H representation & transformation matrices for standard configurations, Jacobian transformation in robotic manipulation		
Module:3	**Dynamics of Robot Manipulator**	**8 hours**
Lagrangian formulation; General expression for kinetic and potential energy of n-link manipulator; Newton-Euler equations of motion; Application of Lagrange–Euler dynamic modelling of robotic manipulators; Two link robotic dynamics with distributed mass		
Module:4	**Trajectory and Path Planning**	**7 hours**
Trajectory planning and avoidance of obstacles; Trajectory for point-to-point motion; Cubic polynomial trajectory, Quintic polynomial; LSPB (Linear segment with parabolic blend); Minimum time trajectory; Trajectories for paths Specified by via points		
Module:5	**Control design for Robotic system**	**7 hours**
Feedback and closed loop control of robotic systems; Trajectory control; Velocity control; Force control; Computed torque control; Linear and Nonlinear controller design of robot		
Module:6	**Robot machine vision and sensor**	**8 hours**
Sensors and sensor-based system in robotics; Machine vision system: Description, Sensing, Digitizing, Image Processing, Analysis and Application; Robotic assembly sensors; Intelligent sensors; Visual servo-control		
Module:7	**Application of Robotics**	**2 hours**
Applications of robotics in active perception; Medical robotics; Autonomous vehicles and other areas		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1.	John J. Craig, "Introduction to Robotics: Mechanics and Control", 4th Edition, Pearson International, 2022
2.	Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", 2nd edition, Wiley, 2020
Reference Books	
1.	M.P. Groover, et.al., "Industrial Robots: Technology, Programming and applications", McGraw Hill, 2nd Indian edition, 2017
2.	M O Tokhi, A K M Azad, "Flexible robot manipulator: modelling, simulation and control" 2nd
3.	Edition, 2017 Ashitava Ghosal, "Robotic fundamental Concept and Analysis", Oxford University Press 11th Impression, 2015
Mode of Evaluation: CAT, Assignment, Quiz, FAT.	

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

Course Code	Course Title	L	T	P	C
BEEE411L	Artificial Intelligence	3	0	0	3
Pre-requisite	BMAT202L, BMAT202P	Syllabus version			
		1.0			

Course Objectives

1. Impart artificial intelligence principles, techniques and its history
2. Assess knowledge representation, problem solving, and learning methods in engineering problems
3. Develop intelligent systems by assembling solutions to concrete computational problems

Course Outcomes

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

1. Evaluate Artificial Intelligence methods and describe their foundations
2. Apply the principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning
3. Demonstrate the knowledge of reasoning and representation for solving real world problems
4. Analyze and illustrate search and planning algorithms in problem solving
5. Implement the AI models for Engineering applications

Module:1	Agents & Environment	6 hours

Benefits and risks in AI, AI technique; Agents: Structure, behavior, intelligence, rationality; Environment: Nature of environment, task environment, properties; Types of agents: Goal based agents, utility-based agents, learning agents

Module:2	Problem Solving	4 hours

Problem representation: Problem space, state space, problem reduction; Case study: Tic - Tac - Toe problem; Solving Approaches: Search algorithms, Heuristics (informed search), Evolutionary computation

Module:3	Search Techniques	8 hours

Problem solving agents; Searching for Solutions; Uninformed Search Strategies: Breadth first search, depth first search, depth limited search, bidirectional search; Informed search strategies: Greedy best-first search, A* search, AO* search; Memory bounded heuristic search; Optimization problems: Hill climbing search, simulated annealing search, local beam search

Module:4	Constraint Satisfaction Problems	6 hours

Constraint propagation; Backtracking search for CSP; Local search for CSP; Adversarial search and games: Optimal decisions and strategies, Monte-Carlo tree search; Minimax search procedure; Alpha-Beta pruning; Additional refinements; Iterative deepening

Module:5	Knowledge Engineering	8 hours

Knowledge base: Representations, mapping of domain knowledge, if-then rules, semantic networks, frames; Predicate logic: Representing instance, computable functions and predicates, resolution, natural deduction; Procedural and declarative knowledge; Logic programming; Forward and backward reasoning; Matching; Representing knowledge in uncertain domain

Module:6	Reasoning and Planning	6 hours

Reasoning Systems for Categories; Reasoning with default information; Probabilistic reasoning: Bayesian networks, hidden Markov models, Kalman filter; Planning: Components of planning system, goal stack planning, hierarchical planning

Module:7	Decision Making	5 hours

Simple decisions: Beliefs, Desires, Combining beliefs and desires under uncertainty, Utility functions, Decision networks; Complex decisions: Sequential decision problems, MDPs, Partially observable MDPs

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	**45 hours**
Text Books		
1.	Russell. S and Norvig. P, “Artificial Intelligence - A Modern Approach”, 4th edition, Pearson, 2022	
2.	Poole. D and Mackworth. A, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press, 2nd Edition, 2017	
Reference Books		
1.	Ric, E., Knight, K and Shankar, B., “Artificial Intelligence”, 3rd edition, Tata McGraw Hill, 2017	
2.	Luger, G.F., “Artificial Intelligence -Structures and Strategies for Complex Problem Solving”, 7th edition, Pearson, 2011	
Mode of Evaluation: CAT, Assignment, Quiz, FAT		
Recommended by Board of Studies	28.05.2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BEIE202L	Computer Architecture and Organization	3	0	0	3
Pre-requisite	BEEE206L, BEEE206P	Syllabus version			
		1.0			

Course Objectives

1. Emphasize on functionality of computers to perform the fixed and floating-point arithmetic operations
2. Demonstrate the memory structure and its mapping
3. Understand the various performance enhancement techniques and parallel processing

Course Outcomes

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

1. Analyze the performance of CPU time
2. Interpretation of floating point and decimal arithmetic's
3. Design and program the various register transfer functions
4. Apply the various mapping techniques and familiarize the data transfer mechanism
5. Analyze the functionality of parallel and vector processing

Module:1	**CPU Organization and Performance**	**4 hours**

Generation of Computers; Functional units, Basic operational concepts; CPU organization by Von-Neumann & Harvard model; Performance analysis of CPU; Data Representation: Fixed point and Floating-point numbers

Module:2	**Fixed-Point Arithmetic**	**8 hours**

Unsigned Addition, Subtraction, Multiplication; Fast Adder; Signed Addition, Subtraction; Signed Multiplication: Booth, Modified Booth and Robertson Algorithm; Division: Restoring, Non-Restoring Algorithm

Module:3	**Decimal and Floating-Point Arithmetic**	**7 hours**

Binary Coded Decimal (BCD Arithmetic's): Addition, Subtraction, Multiplication, Division; Floating point arithmetic: Addition, Subtraction, Multiplication, Division

Module:4	**CPU Design**	**8 hours**

Function of CPU, Register Classification and organization; ALU and control unit; Instruction set with examples, addressing modes, stack organization; Register Transfer, Bus and memory transfers; IO fundamentals: handshaking, buffering, programmed IO, interrupt driven IO; Interrupt handling mechanism; Direct Memory Access (DMA)

Module:5	**Memory Organization**	**8 hours**

Memory organization: Memory interleaving, concept of hierarchical memory organization; cache memory: cache size vs block size, mapping functions, replacement algorithms, write policy; Virtual memory system: Page table, Translation Lookaside Buffer (TLB)

Module:6	**Performance Enhancement Techniques**	**5 hours**

Pipelining: Concepts of pipelining, throughput and speedup; Hazards: Structural, Data and Control; Techniques to overcome the hazards: Data forwarding, Branch prediction

Module:7	**Processor Architecture and Parallel Processing**	**3 hours**

CISC, RISC and VLIW Architecture; Parallel processing: Superscalar, Vector Processor

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

Text Books

1. William Stallings, “Computer Organization and Architecture”, 10th Edition, Prentice Hall, 2018			
2. Morris Mano, Rajib Mall, “Computer System Architecture”, 4th Edition, Pearson Publication, 2020			
Reference Books			
1. JL Hennessy and DA Patterson, “Computer Architecture: A Quantitative Approach”, 6th Edition, Morgan Kaufmann Publisher, 2017			
2. Carl Hamacher, Zvonks Vranesic, Safwat Zaky, “Computer Organization”, 5th Edition, McGraw Hill, 2002			
3. Jim Ledin, “Modern Computer Architecture and Organization”, 1st Edition, Packt Publishing Limited, 2020			
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEIE306L	Data Communication Networks	3	0	0	3
Pre-requisite	BEEE308L	Syllabus version			
		1.0			

Course Objectives

1. Understand the concepts of computer networking, protocols, architectures, and applications
2. Gain expertise in design, implement and analyse performance perspective of TCP/IP layered Architecture
3. Exposure to major issues of the protocols and networking operations

Course Outcomes

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

1. Define the overview of a data communication and network
2. Analyse the bandwidth utilization and switching of data networks
3. Design and apply Communication concepts related to HART and Field Bus.
4. Develop solutions for Configurations of Profibus and Modbus Protocols
5. Appreciate usefulness and importance of Ethernet and Wireless Networks in day-to-day life

Module:1	**Overview of Data Communication**	**7 hours**
Data Communications, Networks, The Internet, Protocols and Standards; Network Models: OSI Model, Layers in the OSI Model, TCP/IP Protocol Suite, Addressing, Physical Layer and Media		
Module:2	**Switching Circuits**	**8 hours**
Multiplexing and Spreading, Transmission Media, Switching: Circuit-Switched Networks, Datagram Networks, Virtual Circuit Networks, Structure of Switches; Queue Management; Packet Classification Algorithm; ATM; LAN; Frame Relays		
Module:3	**HART and Field Bus**	**10 hours**
Hart And Fieldbus: Introduction, HART communication protocol, Communication modes, HART networks, HART commands, HART applications and troubleshooting, Fieldbus: Introduction, General Fieldbus architecture, Basic requirements of Field bus standard, Fieldbus topology, Interoperability, Interchangeability, OLE for process control (OPC)		
Module:4	**Modbus and Profibus**	**9 hours**
Modbus protocol structure, function codes, Troubleshooting; Profibus types: PA, DP, FMS and FP, Profibus protocol stack, Profibus communication model, communication objects, system operation, troubleshooting; Review of foundation field bus; Field bus versus Profibus		
Module:5	**Ethernet and Wireless Networks**	**9 hours**
Industrial Ethernet: Introduction, 10Mbps Ethernet, 100Mbps Ethernet. Gigabit Ethernet; wireless MAC standards: IEEE 802.11, IEEE802.15.4; Zigbee Wireless HART; Wireless standard for process industry; ISA100; Introduction to industrial IoT		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 Hours**

Text Books

1.	Behrouz A. Forouzan, "Data Communications and Networking", McGraw Hill, 5th edition, 2017
2	Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, “Practical Industrial Data networks Design, Installation and Troubleshooting”, Newnes publication, Elsevier, 2005

Reference Books			
1.	Larry L.Peterson, Bruce S.Davie, Computer Networks: A System Approach, 2012, 5th edition, Morgan Kaufmann		
2.	W.Richard Stevens, TCP/IP Illustrated The Protocols, 2012, 2nd edition, Prentice Hall		
3.	A. S. Tanenbaum, "Computer Networks", Pearson education, 6th edition, 2021		
Mode of Evaluation: CAT, Written assignment, Quiz, FAT			
Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BEIE307E	Automated Test Engineering	2	0	2	3
Pre-requisite	BEEE206L, BEEE206P, BEEE208L, BEEE208P	Syllabus version			
		1.0			

Course Objectives

1. Identify the defects in PCB using Automated test equipment
2. Illustrate the various troubleshooting techniques and approaches for PCB
3. Select the suitable testing technique for the PCB

Course Outcomes

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

1. Illustrate the various PCB types and manufacturing process
2. Analyze the defects detected by manual and automated inspection techniques
3. Compare the various approaches in Automation testing
4. Evaluate the reliable conditions of PCB
5. Develop a testing approach at the manufacturing phase of the PCB

Module:1	Printed Circuit Board Manufacturing	3 hours

Types of PCB: Single layer PCB, Multi-layer PCB, PCB Manufacturing techniques: Through-hole Technology, Surface Mount Technology (SMT), Ball Grid array (BGA)Technology, Bare PCB board manufacturing and testing process; Manual and optical inspection testing methods in PCB

Module:2	Fault Identification Methods	3 hours

Troubleshooting of PCB: Identifying the faults by manual inspection and automated optical inspection; Inspection by offline and online; Effects of faults in circuits; Issues in measuring devices: Digital Multimeter (DMM) and Cathode Ray Oscilloscope (CRO); Test gigs: Logic Probe, Logic Pulser, Logic Analyzer; IEC Standards

Module:3	Automated Fault Identification	2 hours

PCB testing approaches: Out-circuit test, In-circuit test, VI signature analysis; Bare board functional testing techniques; Boundary-Scan Test: strategies and procedures

Module:4	Approaches in Automation Testing	5 hours

Test Approaches: Parametric testing, Identify the failures of AC and DC parameters; In-circuit functional testing methods: Back Driving; Guarding; Boundary scan test: Active and passive components, complex devices; Environmental testing; IC testing: Electrical standards and requirements

Module:5	Functional test of PCB board	5 hours

PCB board functional testing: Basic functionality test, cluster test, Go-No-go Test, Guided probe back tracking approach; Simulator based fault simulation: Online and Offline; Emulator techniques: CPU and ROM emulation; Test pod; Boundary scan test: Testing of Boundary scan devices and non-boundary scan devices

Module:6	Reliability and testability of PCB	6 hours

Design for testability: issues, models, Built-in-self test (BIST); Design for reliability: Electrical, Mechanical, Thermal, Thermo-electrical; Grounding techniques for PCB: single point, multipoint, hybrid; EMI and EMC issues

Module:7	Testing at the Manufacturing phase	4 hours

Manufacturability design: Industry manufacturing phases; Production process: various strategies in production, new strategies and benefits; Test equipment and approaches used for manufacturing

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	**30 hours**
List of Challenging Experiments (Indicative)		
1. Functional Test Using Boundary Scan Tester for Printed Circuit Boards (PCBs) implemented at the integrated circuit (IC) level		
2. Cluster Test Using Boundary Scan Tester for PCBs implemented at the integrated circuit (IC) level		
3. Out Circuit Functional Test for a PCB		
4. In Circuit Functional Test for a PCB		
5. QSMVI Signature Test for testing DIP Packages and SMD components		
6. Scan Chain Test for testing Flip-Flops in ICs		
7. Continuity Test Using Short Locater		
8. Analog Test Using Automatic Test Equipment (ATE)		
9. Parametric Testing of DC and AC parameters		
10. VLSI high speed Testing using Automatic Test Equipment		
	Total Laboratory Hours	**30 hours**

Text Book	
1.	S R Sabapathi, G Santhanam, L. Balasubramanium, Sanjay Kumar, "Test Engineering for Electronic Hardware", QMAX test equipment, 2nd Edition, 2017
Reference Books	
1.	R S Khandpur, "Printed Circuit Boards: Design - Fabrication", McGraw Hill Education, 2017
2	Anil K Berwal, "Engineering Thermodynamics", IK International publishing house, 2018
Mode of Evaluation: CAT, Assignment, Quiz, FAT	

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

Course Code	Course Title	L	T	P	C
BEIE308L	Analytical Instrumentation	3	0	0	3
Pre-requisite	BPHY101L, BPHY101P	Syllabus version			
		1.0			

Course Objectives

1. Analyze the various methods of spectrum analysis
2. Examine the radiation sources, detectors and optical systems for various spectroscopy and chromatography instruments
3. Explore the different methods of analysis of radiation detector and industrial gases

Course Outcomes

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

1. Identify the interaction of electromagnetic radiations with matter and spectroscopy and its types
2. Analyze the analytical techniques to determine the elements present in the given sample accurately
3. Apply the concepts of Spectroscopy, Spectrometers, and Chromatography instruments and their working
4. Investigate the concepts of various analytical methods used for instrumental techniques in Industries
5. Evaluate various contemporary measurement techniques related to different analyzers

Module:1	Electromagnetic Radiation	6 hours

Absorption spectroscopy, Electromagnetic radiation and characteristics; Interaction of electromagnetic radiation with matter; Spectral methods analysis, Beer-Lamberts law; Absorption instruments, radiation sources, monochromators, detectors

Module:2	Instrumentation for Absorption and Emission Spectroscopy	8 hours

Ultraviolet and visible absorption spectroscopy: Single beam and double beam spectrophotometers instrumentation, Sources and detectors; Infrared (IR) spectroscopy: Fourier transform infrared spectrometer instrumentation, sources and detectors; Atomic absorption spectroscopy instrumentation: Sources and detectors; Flame emission photometry instrumentation: Sources and detectors, Applications of absorption spectroscopy techniques; Raman spectrometer instrumentation: Sources and detectors

Module:3	Spectrometry Instrumentation and Analysis	7 hours

Nuclear Magnetic Resonance (NMR): Principles, Constructional features, Working and applications; Mass spectroscopy: Principles, Constructional features, Working and applications; X-Ray spectrometer: Principles, Constructional features, Working, Applications and analysis

Module:4	Radiation Detectors	6 hours

Geiger-Muller (GM) counter: Constructional features, Working and applications; Proportional counter: Constructional features, Working and applications; Scintillation counter: Constructional features, Working and applications

Module:5	Chromatography Instrumental Analysis	6 hours

Chromatography: Operation and types, gas chromatography instrumentation and applications; Liquid chromatography instrumentation and applications; High pressure liquid chromatography instrumentation and applications

Module:6	pH Conductivity and Dissolved Component Analyzer	5 hours

pH measurement: Glass electrode, Hydrogen electrodes, Reference electrodes, Selective ion electrodes, Construction and working; Blood gas analyzer: Instrumentation and applications; Dissolved oxygen analyzer: Instrumentation and applications; Sodium analyzer, Water quality analyzer, Silicon analyzer			
Module:7	**Gas Analyzer and applications**		**5 hours**
Gas analyzer: Oxygen analyzer, Zirconia based analyzer; CO monitor; NOx analyzer; Dust detectors; Smoke detectors: Photoelectric smoke detector, Ionization smoke detector; Thermal conductivity analyzer			
Module:8	**Contemporary Issues**		**2 hours**
	Total Lecture hours:		**45 hours**
Text Books			
1.	R.S.Khandpur, “Hand book of Analytical Instruments”, McGraw Hill Publishing Company Ltd., 3rd Edition, 2015		
Reference Books			
1.	Galen W Ewing, “Analytical Instrumentation Handbook”, Taylor & Francis, 4th Edition, 2018		
2.	Willard, H.H., Merrit L.L., Dean J.A Seattle F.L., “Instrumental Methods of Analysis”, 7th edition, CBS Publishing and Distribution, 2012		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	28.05.2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEIE309L	Micro-Electromechanical Systems	3	0	0	3
Pre-requisite	BEEE201L	Syllabus version			
		1.0			

Course Objectives:

1. Explore the overview of Micro Electro Mechanical Systems (MEMS)
2. Understand MEMS material and fabrication technologies
3. Apply MEMS for real-time applications with future scope

Course Outcomes

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

1. Investigate the material properties of MEMS and Manufacturing process
2. Analyze the scaling and modeling of MEMS
3. Design Microsensors and Microactuators
4. Identify the recent trends on optical MEMS and power MEMS
5. Recognize the practical applications of MEMS and the future of MEMS

Module: 1	Microfabrication	4 hours

Microfabrication; Definition of MEMS and Evolution of MEMS over time; MEMS processes; Applications of MEMS

Module: 2	Micro System Manufacturing	8 hours

Integrated circuits; Scaling Laws in Miniaturization; Materials for MEMS and Microsystem; Micromachining: Process of micromachining, surface micromachining, dry micromachining, multilayer micromachining, bulk micromachining, Advantages and Disadvantages of micromachining

Module : 3	Modeling of MEMS	7 hours

Scaling and Modeling; Mechanical systems: Mass-spring, Beam, Membrane; Electrical systems: Micro switches, Micro pumps, Micro valves, Motors; Temperature Profile in a Heated Wire, Electromechanical systems; Reliability and Failure mode analysis

Module: 4	Micro Sensors	7 hours

Construction and Working: Resistive Gauge Sensor, Capacitive and Inductive sensors, Piezoresistive sensors, Position sensors, Gyro sensor, Accelerometer, Pressure and Tactile sensors, Electromagnetic and Electrostatic sensors, Flow sensors

Module: 5	Micro Actuators	6 hours

Architecture of MEMS as Actuators: Microplates, Shape alloys, Magnetic Actuators and Relay, Fluid Actuators, Thermal actuators and Relays, Micropumps, Microvalves, Advantages and limitations of MEMS as actuators

Module: 6	Optical MEMS and Power MEMS	6 hours

Optical MEMS: Micro LED, Optical Relays, Micro Opto electromechanical systems, Micro mirrors, Micro lenses; Power MEMS: Vibration, Thermal, Pressure, Light and Magnetic energy harvesting, Power harvesting, Advantages, Limitations and Disadvantages of Power MEMS

Module: 7	Applications of MEMS	5 hours

Case studies in Healthcare; Radio frequency MEMS; System on Chip; Chemical MEMS; MEMS for programmable device arrays; Evolution of Nano Electro-Mechanical System(NEMS)

Module: 8	Contemporary Issues	2 hours

	Total Lecture hours:	**45 hours**

Text Books

1. Castaner, L., “Understanding MEMS: Principles and Applications”. John Wiley & Sons, 2015
2. Kim, E.S., “Fundamentals of Microelectromechanical Systems (MEMS)”, McGraw-Hill Education, 2021

Reference Books

1. MarkkuTilli, Mervi Paulasto Krockel, “Handbook of Silicon Based MEMS Materials and Technologies”, 3rd edition, Elsevier, 2020
2. Bijoy Bhattacharyya, “Electrochemical Micromachining for Nanofabrication, MEMS and Nanotechnology”, Elsevier, 2015
3. Pelesko, John A., and David H. Bernstein, “Modeling MEMS and NEMS”, CRC press, 2007

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

Course Code	Course Title	L	T	P	C
BEIE310L	Optical Instrumentation	3	0	0	3
Pre-requisite	BPHY101L, BPHY101P	Syllabus version			
		1.0			

Course Objectives

1. Understand the principles underlying the theory and applications of optical instrumentation
2. Design aspects of optical instrument for non-contact and fiber optic-based measurements
3. Provide a broad exposure on latest developments in optical instrumentation

Course Outcomes

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

1. Infer the characteristics of optical sources, detectors and fibers used for measurements
2. Design fiber optic sensors for various physical parameter measurements
3. Design laser based optical instrumentation
4. Design of laser based non-destructive testing
5. Choose an appropriate optical instrument for advanced measurements

Module:1	**Overview of Optical Instrumentation**	**3 hours**

Noncontact measurements: Principles and advantages, Competing technologies, Classification of optical measurements

Module:2	**Optical Sources and detectors**	**10 hours**

Principle of light emission: Materials, Population inversion, pumping processes, Optical amplification; Semiconductor optical sources; Homojunction and double heterostructure; LEDs and LASERs; Response time, design of drive circuitry; Classifications: Neodymium Lasers, CO2 Lasers, Dye Lasers, Fiber lasers; Detectors: PN, P-i-N and Avalanche Photodiodes (APD), Quadrant photodiode, CCD cameras and displays

Module:3	**Fundamentals of Fiber Optics**	**5 hours**

Optical fiber characteristics and classifications; Attenuation and dispersion; Light coupling: Source-to-fiber coupling, Fiber-fiber coupling, Fiber connectors; Splices: Splicing techniques; Fiber Amplifier and optical modulators

Module:4	**Fiber Optic Sensors**	**5 hours**

Fiber optic sensors: measurement of displacement, pressure, temperature, acceleration, torque, strain, fluid level and flow; Electric and magnetic field sensors; Rotation rate sensors; Fiber Bragg Grating and Distributed fiber optic sensors

Module:5	**Laser Instrumentation**	**8 hours**

Principles of laser measurements and applications; Laser Interferometer: Principle, performance parameters and applications; Alignment, position and sizing Instruments: Position detecting sensor, wire diameter sensor, particle sizing; Laser doppler velocimetry: Principle of operation, performance parameters, electronic processing of doppler signal; Holography: Principles, Methods of holographic interferometry and applications; Laser distance measurements; Laser safety

Module:6	**Advanced optical Instrumentation**	**5 hours**

Laser speckle, Infrared thermography, Endoscopy, Terahertz technology; Laser remote sensing (LiDAR); Advanced optical pollution measurements, optical imaging, lithography, spectrometers, laser ultrasonics; Case studies on medical applications of laser

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

Text Books	
1.	David A. Krohn, Trevor W. MacDougall and Alexis Mendez, "Fiber optic Sensors: Fundamental and Applications", SPIE, 4th edition, 2015
2.	SilvanoDonati, “Electro-Optical Instrumentation: Sensing and Measurements with lasers”, PHI, 2010
Reference Books	
1.	Gerd Keiser, "Optical Fiber Communications", Tata McGraw Hill, 5th edition, 2017
2.	W. Osten and N. Reingand, P, "Advanced Methods for Optical Nondestructive Testing, in Optical Imaging and Metrology: Advanced Technologies", Wiley-VCH Verlag GmbH & Co. KGaA, 2012
3.	A.K.Ganguly, " Optical and Optoelectronics Instrumentation", Alpha Science Intl Ltd, 2010

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

BEIE391J	Technical Answers to Real Problems Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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

Course Outcome:

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

Module Content

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

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

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

General Guidelines:

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

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

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

BEIE392J	Design Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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

Course Outcome:

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

Module Content

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

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

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

BEIE393J	Laboratory Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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

Course Outcome:

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

Module Content

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

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

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

BEIE394J	Product Development Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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

Course Outcome:

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

Module Content

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

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

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

BEIE395J	Computer Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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

Course Outcome:

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

Module Content

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

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

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

BEIE396J	Reading Course	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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

Course Outcome:

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

Module Content

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

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

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

BEIE397J	Special Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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

Course Outcome:

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

Module Content

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

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

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

BEIE398J	Simulation Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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

Course Outcome:

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

Module Content

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

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

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

Course code	Course Title	L	T	P	C
BEIE401E	Testing and Calibration	2	0	2	3
Pre-requisite	BEIE201L, BEIE201P	Syllabus version			
		1.0			

Course Objectives

1. Appreciate testing and calibration of various parameters
2. Handle calibration laboratories and manage calibration system in an organisation
3. Accomplish ITS, IEC, ASTM, RS-232 standards with regard to laboratory management

Course Outcome

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

1. Calibrate and estimate the uncertainty
2. Implement and maintain the standards in laboratory
3. Apply the calibration procedures for various parameters

Module:1	**Testing & Standards**	**3 hours**
Measurement units; Standards and traceability; Uncertainty: Components, estimation, evaluation, reporting; Calibration and insulation; Types of Standards		
Module:2	**Calibration system**	**3 hours**
Calibration procedures; Industry practices and regulations; Control of calibration environment; Manual and Automated calibration; Calibration results: Reporting, record management		
Module:3	**Calibration of Power Quality**	**3 hours**
Calibration of Power meter: Methods, trends, standards, specification; Fluke 345 clamp meter; Case study: Application of power quality and clamp meter in industrial drives and switching		
Module:4	**Calibration of AC/ DC Electronic Equipment**	**5 hours**
Multi product calibrator: Measurement Uncertainty, AC/DC meter Calibration, performance test, IEC61010 standards, IEEE488, RS-232; Fluke 5502A; Oscilloscope Calibration: Procedure, verification of vertical deflection, pulse response, bandwidth, horizontal timing; Trigger operation		
Module:5	**Calibration of Temperature Sensors**	**4 hours**
Calibration of RTD, Thermistor and Thermocouple; Performance test; Calibration adjustment; ITS-90 standards; Calculating uncertainty; Tolerance testing: ASTM-E1137, Fluke 9142A, Fluke 1586A, Fluke 5627A		
Module:6	**Calibration of Pressure Sensors**	**4 hours**
Procedure, Performance test, calibration adjustment; Standards: IEC61010-1, IP 67, IP 40, MIL-PRF-28800F; Fluke calibrators: Fluke 3130, Fluke 2700G, Fluke 700HTPK		
Module:7	**Calibration of Level and Flow Sensors**	**6 hours**
Considerations with Level sensor calibration; Calibration Procedure: Differential pressure level & flow transmitters, Capacitive level transmitter; Ultrasonic level transmitter, Magnetic flowmeter, Gravimetric method for flowmeter		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Indicative Experiments

1.	Perform comparative study on digital pressure calibrator
2.	Conduct an experiment for RTD and thermocouple probe calibration
3.	Conduct a test to verify and validate a hygrometer for measuring humidity and perform uncertainty analysis
4.	Perform calibration and uncertainty analysis for a given thermistor for measuring the temperature of a system between 25 and 150 C

5.	Configure and calibrate the given k-type thermocouple for measuring the temperature of a system between 25 and 150 ℃			
6.	Perform calibration and uncertainty analysis for a digital storage oscilloscope			
7.	Perform calibration and uncertainty analysis for AC and DC Voltmeter			
8.	Perform calibration and uncertainty analysis for digital Multimeter			
9.	Perform calibration and uncertainty analysis for AC and DC Ammeter			
10.	Perform a comparative study of high pressure sensing devices using hydraulic calibrator			
		Total Laboratory Hours		**30 hours**
Text Books				
1.	Alessandro Brunelli, “Calibration Handbook of Measuring Instruments”, 1st edition, ISA, 2017			
2.	Ronald H. Dieck, “Measurement Uncertainty: Methods and Applications”, 5th Edition, ISA, 2017			
Reference Book				
1.	Samiha Mourad, Yervant Zorian, “Principles of testing electronic systems”, John Wiley & Sons, 2000			
2.	Mike Cable, "Calibration: A Technician's Guide", ISA publications, 2007			
Mode of Evaluation: CAT, Assignments, Quiz, FAT				
Recommended by Board of Studies		28.05.2022		
Approved by Academic Council		No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BEIE401E	Testing and Calibration	2	0	2	3
Pre-requisite	BEIE201L, BEIE201P	Syllabus version			
		1.0			

Course Objectives

1. Appreciate testing and calibration of various parameters
2. Handle calibration laboratories and manage calibration system in an organisation
3. Accomplish ITS, IEC, ASTM, RS-232 standards with regard to laboratory management

Course Outcome

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

1. Calibrate and estimate the uncertainty
2. Implement and maintain the standards in laboratory
3. Apply the calibration procedures for various parameters

Module:1	**Testing & Standards**	**3 hours**

Measurement units; Standards and traceability; Uncertainty: Components, estimation, evaluation, reporting; Calibration and insulation; Types of Standards

Module:2	**Calibration system**	**3 hours**

Calibration procedures; Industry practices and regulations; Control of calibration environment; Manual and Automated calibration; Calibration results: Reporting, record management

Module:3	**Calibration of Power Quality**	**3 hours**

Calibration of Power meter: Methods, trends, standards, specification; Fluke 345 clamp meter; Case study: Application of power quality and clamp meter in industrial drives and switching

Module:4	**Calibration of AC/ DC Electronic Equipment**	**5 hours**

Multi product calibrator: Measurement Uncertainty, AC/DC meter Calibration, performance test, IEC61010 standards, IEEE488, RS-232; Fluke 5502A; Oscilloscope Calibration: Procedure, verification of vertical deflection, pulse response, bandwidth, horizontal timing; Trigger operation

Module:5	**Calibration of Temperature Sensors**	**4 hours**

Calibration of RTD, Thermistor and Thermocouple; Performance test; Calibration adjustment; ITS-90 standards; Calculating uncertainty; Tolerance testing: ASTM-E1137, Fluke 9142A, Fluke 1586A, Fluke 5627A

Module:6	**Calibration of Pressure Sensors**	**4 hours**

Procedure, Performance test, calibration adjustment; Standards: IEC61010-1, IP 67, IP 40, MIL-PRF-28800F; Fluke calibrators: Fluke 3130, Fluke 2700G, Fluke 700HTPK

Module:7	**Calibration of Level and Flow Sensors**	**6 hours**

Considerations with Level sensor calibration; Calibration Procedure: Differential pressure level & flow transmitters, Capacitive level transmitter; Ultrasonic level transmitter, Magnetic flowmeter, Gravimetric method for flowmeter

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Indicative Experiments

1.	Perform comparative study on digital pressure calibrator
2.	Conduct an experiment for RTD and thermocouple probe calibration
3.	Conduct a test to verify and validate a hygrometer for measuring humidity and perform uncertainty analysis
4.	Perform calibration and uncertainty analysis for a given thermistor for measuring the temperature of a system between 25 and 150 C

5.	Configure and calibrate the given k-type thermocouple for measuring the temperature of a system between 25 and 150 ℃			
6.	Perform calibration and uncertainty analysis for a digital storage oscilloscope			
7.	Perform calibration and uncertainty analysis for AC and DC Voltmeter			
8.	Perform calibration and uncertainty analysis for digital Multimeter			
9.	Perform calibration and uncertainty analysis for AC and DC Ammeter			
10.	Perform a comparative study of high pressure sensing devices using hydraulic calibrator			
		Total Laboratory Hours		**30 hours**
Text Books				
1.	Alessandro Brunelli, “Calibration Handbook of Measuring Instruments”, 1st edition, ISA, 2017			
2.	Ronald H. Dieck, “Measurement Uncertainty: Methods and Applications”, 5th Edition, ISA, 2017			
Reference Book				
1.	Samiha Mourad, Yervant Zorian, “Principles of testing electronic systems”, John Wiley & Sons, 2000			
2.	Mike Cable, "Calibration: A Technician's Guide", ISA publications, 2007			
Mode of Evaluation: CAT, Assignments, Quiz, FAT				
Recommended by Board of Studies		28.05.2022		
Approved by Academic Council		No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BEIE402L	Non-Destructive Testing	3	0	0	3
Pre-requisite	BPHY101L. BPHY101P	Syllabus version			
		1.0			

Course Objectives

1. Demonstrate the concepts of surface inspection techniques
2. Comprehend Non-destructive testing methods and its industrial applications
3. Formulate special and advanced Non-destructive testing method

Course Outcomes

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

1. Determine the types of Visual inspection techniques for flaw detection and characterization of industrial components
2. Develop and demonstrate liquid penetrant testing methods
3. Acquire the skills of magnetic particle and eddy current testing
4. Apply modern tools for radiographic testing and ultrasonic testing
5. Promote advancement of research and implementation of NDE technology

Module:1	Visual Testing	5 hours

Vision, Lighting, Material attributes, Environmental factors, Visual perception; Direct and indirect methods: Mirrors, Magnifiers, Boroscopes, Fibroscopes, Closed circuit television; Light sources and special lighting: Lighting systems, Computer enhanced system; Standards and codes of visual testing

Module:2	Liquid Penetrant Testing	6 hours

Principles, Types and properties of liquid penetrants; Developers: Advantages and limitations of various methods; Preparation of test materials; Application of penetrants to parts; Removal of surface penetrants; Post cleaning; Selection of penetrant method: Solvent removable, Water washable; Standards and codes of LPI

Module:3	Magnetic Particle and Eddy Current Testing	8 hours

Theory of magnetism; Depth of penetration factors; Direct pulsating current; Typical fields of direct and indirect methods, Advantages; Magnetisation techniques: Prods technique, Longitudinal magnetization, Circular magnetization, Current calculations; Magnetic Burghausan Noise Analysis (MBN); Generation of eddy currents : Eddy current sensing elements, Probes; Type of coil arrangement: Operation, Applications, Advantages, Limitations; Low frequency and Remote Field Eddy Current Techniques; Pulsed Eddy Current Technique

Module:4	Radiographic Testing	8 hours

RT: X-rays, Properties of X-rays relevant to NDE, Absorption of rays, Scattering, types and use of filters, Screens, Geometric factors, Inverse square law; Film type and processing: Characteristics of films, Density, Speed, Contrast, Characteristic curves; Penetrameters; Exposure charts; Radiographic equivalence; Radiography of pipes; Welds and castings. Safety with X-rays; Special Radiographic Techniques

Module:5	Ultrasonic Testing	8 hours

Ultrasonic NDT principles; Different types of wave modes; Physics of wave generation; Reception of Ultrasonic waves; Interactions and propagation; Calibration; Data collection; Quantification and interpretation; New methods using guided waves; Resonance and other Low Frequency Methods; Angle beam inspection; Thickness measurements; Applications.

Module:6	Special Techniques and NDT Standards	8 hours

Laser Interferometry Techniques; Holography Techniques; Acoustic emission technique; Pressure and leak testing; Wear monitoring; Automatic Defect Recognition algorithms; Hybrid techniques in NDT; Sonotherm; Condition monitoring of machines; NDE sensors for process monitoring; Non-Destructive testing standards: ASTM, ISO, ASNT, API, ASME, Boiler and Pressure Vessel codes

Module:7	Contemporary Issues	2 hours

	Total Lecture hours:	**45 Hours**
Text Book		
1.	Wong B Stephen, “Non-Destructive Testing - Theory, Practice and Industrial Applications”, Lambert Academic Publishing, USA, 2014	
Reference Books		
1.	Charles, J. Hellier, “Handbook of Non-destructive Evaluation”, 3rd edition, McGraw Hill, New York, 2020	
2.	J. Prasad and C. G. K. Nair, “Non-Destructive Test and Evaluation of Materials”, 2nd edition, Tata McGraw-Hill Education, 2011	
3	A. S. Paipetis,T. E Matikas and D. G. Aggelis, “Emerging Technologies in Non-Destructive Testing”, CRC Press, 2012	
Mode of Evaluation: CAT, Assignment, Quiz, FAT		
Recommended by Board of Studies	28.05.2022	
Approved by Academic Council	No. 66	Date 16-06-2022

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 **Io** I 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 I 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 I Social Issues 1

Harassment - Types - Prevention of harassment, Violence and Terrorism.

Module:3 I Social Issues 2

Corruption: Ethical values, causes, impact, laws, prevention - Electoral malpractices;
White collar crimes - Tax evasions - Unfair trade practices.

Module:4 I 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 I Drug Abuse

Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention.

Module:6 I Personal and Professional Ethics

Dishonesty - Stealinq - Malpractices in Examinations - Plaqiarism.

Module:7 I Abuse of Technologies

Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networkinq websites.

Total Lecture Hours: I 60 hours

Text Books:

1.	R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2019, 2nd Revised Edition, Excel Books, New Delhi.
2.	Hartmann, N., "Moral Values", 2017, United Kingdom: Taylor & Francis.

Reference Books :

1.	Rachels, James & Stuart Rachels, "The Elements of Moral Philosophy", 9th edition, 2019, New York: McGraw-Hill Education.

2.	Blackburn, S. "Ethics: A Very Short Introduction", 2001, Oxford University Press.
3.	Dhaliwal, K.K, "Gandhian Philosophy of Ethics: A Study of Relationship between his Presuoooosition and Precepts", 2016, Writers Choice, New Delhi, India.
4	Ministry of Social Justice and Empowerment, "Magnitude of Substance Use in India", 2019, Government of India.
5.	Ministry of Home Affairs, "Accidental Deaths and Suicides in India", 2019, Government of India.
6.	Ministry of Home Affairs, "A Handbook for Adolescents/ Students on Cyber Safety", 2018, Government of India.
Mode of Evaluation: Poster making, Quiz and Term End - Quiz	
Recommended by Board of Studies	2?-10-2021
Aooroved bv Academic Council	No. 64 Date 16-12-2021

BSSC101N	Essence of Traditional Knowledge	IL IT IP IC
		0 0 0 2
Pre-requisite	**Nil**	**Syllabus version**
		1.0

Course Objectives:

1. To impart the knowledge on Indian tradition and Culture.
2. To enable the students to acquire the traditional knowledge in different sectors.
3. To analyze and understand the Science, Management and Indian Knowledge System.

Course Outcomes:

1. Familiarize the concept of Traditional Indian Culture and Knowledge.
2. Explore the Indian religion, philosophy and practices.
3. Analyze and understand the Indian Languages, Culture, Literature and Arts.
4. Gives a clear understanding on the Indian perspective of modern scientific world and basic principles of Yoga and holistic health care system of India.
5. Enable knowledqe on Leqal framework and traditional knowledqe.

Module:1 Introduction to Traditional Knowledge

Traditional knowledge: Definition, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge, characteristics, Traditional knowledge vis-a-vis Indigenous knowledge, Traditional knowledge Vs Western Knowledge.

Module:2 Culture and Civilization

Introduction to Culture and Civilization, Culture and Heritage, Characteristics features of Indian Culture, Importance of Culture, Cultural practices in Ancient India, Medieval India and Modern India.

Module:3 Languages and Literature

Indian Languages and Literature: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature and literatures of South India.

Module:4 Religion and Philosophy

Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Reliqious Reform Movements in Modern India (selected movements only).

Module:5 Fine Arts in India

Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama. Science and Technology in India, Development of science in ancient, medieval and modern India. Traditional Medicine - Herbal Healing - Yoga and Pranayama practices.

Module:6 Traditional Knowledge in different sectors

Traditional knowledge and engineering, Traditional medicine system, Traditional knowledge in agriculture, Dependence of Traditional Societies on food and healthcare needs; Importance of conservation and sustainable development of environment, Management of biodiversity and Protection of Traditional knowledqe.

Module:7 Legal framework and Traditional Knowledge

Introduction on Legal framework and Traditional Knowledge: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, The protection of traditional knowledqe bill, 2016.

Total Lecture Hours: 60 hours

Text Books:

1. Shikha Jain, Parul G Munjal And Somya Joshi,(2020) Traditional Knowledge Systems And Cultural Heritage, Aryan Books International, India.
2. Anindya Bhukta(2020), Legal Protection for Traditional Knowledge: Towards A New

	Law for Indigenous Intellectual Property, Emerald Publishing Limited, United Kingdom.
Reference Books :	
1.	Traditional Knowledge System in India, by Amit Jha, 2009.
2.	Basant Kumar Mohanta & Vipin Kumar Singh (2012), "Traditional Knowledge System & Technology in India", Pratibha Prakashan, India.
3.	S. Baliyan, Indian Art and Culture, Oxford University Press, India.
4	http://indiafacts.org/author/michel-danino/
5.	GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi,2016.
Mode of Evaluation: Quiz and Term End - Quiz	
Recommended by Board of Studies	16-11-2021
Approved by Academic Council	No. 64 | Date | 16-12-2021

BEEE399J	Summer Industrial Internship	L	T	P	C
		0	0	0	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.

Course Outcome:

1. Demonstrate professional and ethical responsibility.
2. Understand the impact of engineering solutions in a global, economic, environmental and societal context.
3. Develop the ability to engage in research and to involve in life-long learning.
4. Comprehend contemporary issues.

Module Content

Four weeks of work at industry site.
Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

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

BEEE497J	Project - I	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcome:

1. Demonstrate professional and ethical responsibility.
2. Evaluate evidence to determine and implement best practice.
3. Mentor and support peers to achieve excellence in practice of the discipline.
4. Work in multi-disciplinary teams and provide solutions to problems that arise in multi-disciplinary work.

Module Content

Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.

Can be individual work or a group project, with a maximum of 3 students.

In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.

Carried out inside or outside the university, in any relevant industry or research institution.

Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews

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

BEEE498J	Project – II / Internship	L	T	P	C
		0	0	0	5
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcome:

1. Formulate specific problem statements for well-defined real life problems with reasona-ble assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing.
5. Synthesize the results and arrive at scientific conclusions / products / solution.
6. Document the results in the form of technical report / presentation.

Module Content

1. Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Can be individual work or a group project, with a maximum of 3 students.
4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
5. Carried out inside or outside the university, in any relevant industry or research institution.
6. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews.

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