ESTD : 1946

2022

OBE & CBCS

CURRICULUM

UNDERGRADUATE PROGRAMME

Second Year

Department of Electrical & Electronics Engineering (2024-2028)

THE NATIONAL INSTITUTE OF ENGINEERING

(An Autonomous Institute under Visvesvaraya Technology University, Belagavi)

Recognised by AICTE, New Delhi

Manandavadi Road, Mysuru - 570 008

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Department Vision

The department will be an internationally recognized centre of excellence imparting quality education in electrical engineering for the benefit of academia, industry, and society at large.

Department Mission

M1: Impart quality education in Electrical and Electronics Engineering through theory and its applications by dedicated and competent faculty.

M2: Nurture creative thinking and competence leading to innovation and technological growth in the overall ambit of Electrical Engineering

M3: Strengthen industry-institute interaction to inculcate best engineering practices for sustainable development of the society

Program Educational Objectives

PEO1: Graduates will be competitive and excel in Electrical industry and other organizations.

PEO2: Graduates will pursue higher education and will be competent in their chosen domain.

PEO3: Graduates will demonstrate leadership qualities with professional standards for sustainable development of society

Programme Outcomes

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
9. **Individual and teamwork:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes

Our Electrical and Electronics Engineering graduates will have the ability to:

PSO1: Apply the knowledge of Basic Sciences, Electrical and Electronics Engineering and Computer Engineering to analyse, design and solve real world problems in the domain of Electrical Engineering.

PSO2: Use and apply state-of-the-art tools to solve problems in the field of Electrical Engineering.

PSO3: Be a team member and leader with awareness to professional engineering practice and capable of lifelong learning to serve society

TABLE OF SCHEME AND EXAMINATION FOR III SEMESTER (2024-28 Batch)

Sl. No	Type of Course	Course Code	Course Title	Teaching Department (TD)	Question Paper setting Board (PSB)	Teaching Hrs/Week				Examination				Credits
						L	T	P	S	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	BEE301	Electric Power Generation, Transmission and Distribution	EE		3	0	0		3	50	50	100	**3**
2	IPCC	BEE302	Digital Electronics	EE		3	0	2		3	50	50	100	**4**
3	PCC	BEE303	Electrical Machines	EE		3	0	0		3	50	50	100	**3**
4	PCC	BEE304	Analog Electronics	EE		3	2	0		3	50	50	100	**4**
5	PCCL	BEEL305	Electrical Machines Lab	EE		0	0	2		3	50	50	100	**1**
6	ESC	BXX306x	ESC/ ETC/ PLC	EE		3	0	0		3	50	50	100	**3**
7	UHV	BSCK307	Social Connect & Responsibility	EE		0	0	2		1	50	_	100	**1**
8	AEC/ SEC	BEE358x	Ability Enhancement Course (AEC)/Skill Enhancement Course (SEC) – III	EE		If the course is a Theory 1 If the course is a Laboratory 0	0 0	0 2		- -	50	_	50	**1**
9	MC	BNSK359	National Service Scheme (NSS)	NSS Coordinator		0	0	2		_	100	_	100	**0**
		BPEK359	Physical Education (PE) Sports & Athletics	PED										
		BYOK359	Yoga	Yoga Teacher										
Engineering Science Course (ESC/ETC/PLC)														
1	ESC	BEE306A	Mathematics for Signal Processing	EE		3	0	0		3	50	50	100	**3**
2	ESC	BEE306B	Electrical Measurements and Instrumentation	EE		3	0	0		3	50	50	100	**3**
3	ESC	BEE306C	Electromagnetic Fields	EE		3	0	0		3	50	50	100	**3**
4	ETC	BEE306D	Semiconductor Devices	EE		3	0	0		3	50	50	100	**3**
5	ESC	BEE306E	Sensors and Signal Conditioning	EE		3	0	0		3	50	50	100	**3**
Ability Enhancement Course – III														
1	SEC	BEE358A	Testing of Electrical Apparatus	EE		0	0	2		2	50	_	50	**1**
2	SEC	BEE358C	Electrical Hardware Laboratory	EE		0	0	2		2	50	_	50	**1**
3	AEC	BEE358E	Electrical Safety and Risk Management	EE		1	0	0		2	50	_	50	**1**
4	AEC	BEE358F	PCB Design using ORCAD/KiCAD	EE		1	0	0		2	50	_	50	**1**
4	SEC	BEE358G	Object Oriented Programming with C++	EE		0	0	2		2	50	_	50	**1**

Note:*Max. Marks = CIE out of 100 marks scaled down to 50 marks + SEE out of 100 marks scaled down to 50 marks.*
Max. Marks = CIE out of 100 marks, for courses with no SEE.

TABLE OF SCHEME AND EXAMINATION FOR IV SEMESTER (2024-28 Batch)

Sl. No	Type of Course	Course Code	Course Title	Teaching Department (TD)	Question Paper setting Board (PSB)	Teaching Hrs/Week				Examination				Credits
						L	T	P	S	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	BEE401	Power Electronics	EE		3	0	0		3	50	50	100	**3**
2	IPCC	BEE402	Analysis of Electrical Machines	EE		3	0	2		3	50	50	100	**4**
3	PCC	BEE403	Electrical Network Analysis	EE		3	2	0		3	50	50	100	**4**
4	PCCL	BEEL404	Power Electronics Lab	EE		0	0	2		3	50	50	100	**1**
5	ESC	BEE405x	ESC/ ETC/ PLC	EE		3	0	0		3	50	50	100	**3**
6 7	AEC/ SEC	BEE456x	Ability Enhancement Course (AEC)/Skill Enhancement Course (SEC) – IV	EE		If the course is a Theory 1 If the course is a Laboratory 0	1 0	1 0	 	- -	50	-	50	**1**
8	BSC	BBOE407	Biology for Engineers	EE/Basic Science		3	0	0		3	50	50	100	**3**
9	UHV	BUHK408	Universal Human Values Course	EE		1	0	0		1	50	50	100	**1**
10	MC	BNSK459	National Service Scheme (NSS)	NSS Coordinator		0	0	2		_	100	_	100	**0**
		BPEK459	Physical Education (PE) Sports & Athletics	PED										
		BYOK459	Yoga	Yoga Teacher										
Engineering Science Course (ESC/ETC/PLC)														
1	ESC	BEE405A	Introduction to VLSI circuits	EE		3	0	0		3	50	50	100	**3**
2	ESC	BEE405C	Communication Engineering	EE		3	0	0		3	50	50	100	**3**
3	ESC	BEE405D	Distributed Generation and Microgrid	EE		3	0	0		3	50	50	100	**3**
4	ESC	BEE405E	Probability and Statistics	EE		3	0	0		3	50	50	100	**3**
Ability Enhancement Course – III														
1	SEC	BEE456A	Circuit Laboratory using PSPICE	EE		0	0	2		2	50	_	50	**1**
2	SEC	BEE456B	ARM Microcontroller Programming	EE		0	0	2		2	50	_	50	**1**
3	AEC	BEE456C	Testing of Electrical Apparatus	EE		0	0	2		2	50	_	50	**1**
4	SEC	BEE456D	Selection of Power Converter Components	EE		0	0	2		2	50	_	50	**1**
5	SEC	BEE456E	Introduction to Verilog /VHDL coding	EE		0	0	2		2	50	_	50	**1**

Note:*Max. Marks = CIE out of 100 marks scaled down to 50 marks + SEE out of 100 marks scaled down to 50 marks.*
Max. Marks = CIE out of 100 marks, for courses with no SEE.

B.E Electrical and Electronics Engineering

(2023-2027)

Syllabus – III Semester

Department of Electrical and Electronics Engineering

The National Institute of Engineering

Mysuru-570 008

Course Code: BEE301
Credits: 3
L:T:P:S - 3:0:0:0
SEE Hours: 3 Hrs

Course Name: Electric Power Generation, Transmission and Distribution
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To familiarize students with power generation fundamentals 2. To develop proficiency in transmission systems and derive the mathematical models 3. To demonstrate transmission line performance evaluation using mathematical modelling 4. To provide engineering insight into distribution systems

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		Bloom's level
CO1	Describe various aspects of power generation, transmission and distribution	Understand
CO2	Evaluate the electrical and mechanical parameters of power systems	Apply
CO3	Analyse and evaluate the performance of transmission systems using mathematical models	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3		-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-		3	-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Power Generation		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Structure of power systems – single line diagram	1	Nil
1.2	Distributed generation and cogeneration	1	Nil
1.3	IS/IEC codes and specification requirements regarding generation	1	Nil
1.4	Important terms & factors of power stations, Peak load and base load plants with numerical problems	3	Nil
1.5	Importance and improvement methods of power factor with numerical problems	1	Nil
1.6	Cost of electrical energy with numerical problems	1	Nil
Module – 2: Power Transmission			
2.1	Standard transmission voltages, Power handling capacity and line losses, Transmission line conductor materials and types of conductors	2	Nil
2.2	Underground cables – construction and types	1	Nil
2.3	Resistance of transmission line conductors and skin effect	1	Nil
2.4	Inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Concept of GMR and GMD with detailed derivations and numerical problems	4	Nil
2.5	Average values of line parameters for different lines, Proximity effect.	1	Nil
Module – 3: Modelling and Performance Evaluation of Transmission System			
3.1	Classification and modelling of transmission lines – derivation of ABCD parameters for short, medium and long transmission lines.	2	Nil
3.2	Performance evaluation of short transmission lines in terms of voltage regulation, efficiency & power factor	1	Nil
3.3	Performance evaluation of medium transmission lines (Nominal T and nominal π methods) in terms of voltage regulation, efficiency & power factor	2	Nil
3.4	Performance evaluation of long transmission lines in terms of voltage regulation, efficiency & power factor	2	Nil
3.5	Surge impedance and Surge Impedance Loading (SIL), Ferranti effect	1	Nil

Module – 4: Components of Transmission System			
4.1	Insulating materials and types of overhead line insulators, voltage distribution along the string of insulators, pollution mitigation techniques	2	Nil
4.2	Corona – definition, derivation of critical disruptive voltage, visual corona, corona loss	2	Nil
4.3	Sag, Types of vibrations & oscillations, Dampers & spacers.	3	Nil
4.4	Power line carrier communication	1	Nil
Module – 5: Power Distribution			
5.1	Distribution systems: Types, feeder, distributor types & mains, Kelvin's law	2	Nil
5.2	Influence of voltage on the size of feeder and distributor	1	Nil
5.3	AC distributors: 3 phase four wire system with balanced and unbalanced loads	2	Nil
5.4	Substation lay-out, Distribution transformer	1	Nil
5.5	Stepped main and tapered main	1	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. S N Singh, **"Electric Power Generation Transmission and Distribution"**, 2nd edition PHI, 2008.
2. V K Mehta, Rohit Mehta, **"Principles of Power System",** 4th edition, S Chand publication, 2007.

Reference Books:

1. A Chakrabarti, M L Soni, P V Gupta and U S Bhatnagar, **"Power System Engineering",**Dhanpat Rai and Sons, New Delhi, 2016.
2. D.P.Kothari, I.J.Nagarath, **"Power System Engineering",** Tata Mc Graw -Hill Publishing Company limited, New Delhi, 2007.
3. Rakosh Das Begamudre, **"Extra High Voltage AC Transmission Engineering",** 4th edition, New Age International Publishers, 2011.

Course Code: BEE302
Credits: 4
L:T:P:S - 3:0:2:0
SEE Hours: 3 Hrs

Course Name: Digital Electronics
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To have an insight on Boolean minimization techniques and combinational circuit design 2. To develop skill in sequential system design and analysis. 3. To demonstrate memory systems and FPGA prototyping using programmable logic devices.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Apply basic theorems of Boolean algebra and map techniques to optimise Boolean expressions	Apply
CO2	Design and realise combinational circuits	Apply
CO3	Design and realise sequential circuits	Apply
CO4	Simulate and implement digital systems using FPGA	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	3	1	3	-	-	-	3	3	-	1		3	3	2
CO2	3	3	3	1	3	-	-	-	3	3	-	1		3	3	2
CO3	3	3	3	1	3	-	-	-	3	3	-	1		3	3	2
CO4	3	1	3	1	3	-	-	-	3	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Gate Level Minimisation		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Basic theorems and properties of Boolean Algebra	2	Nil
1.2	Standard Forms, Map Simplification	2	Nil
1.3	Map Manipulation (restricted to four variables), Technology mapping	2	Nil
Module – 2: Combinational Logic			
2.1	Combinational functional blocks, Rudimentary logic functions	2	Nil
2.2	3 to 8 decoder, priority encoder, 8×1 multiplexer	3	Nil
2.3	Combinational Logic Design: Design procedure, hierarchical design	2	Nil
2.4	Iterative combinational circuits, binary adders, binary subtractors, binary adder-subtractors and other arithmetic functions	3	Nil
Module – 3: Synchronous Sequential Logic			
3.1	Sequential Circuits: characteristic equations and excitation table for flip-flops	1	Nil
3.2	Sequential circuit Analysis, State reduction and assignment	3	Nil
3.3	Sequential circuits Design	4	Nil
Module – 4: Registers and Counters			
4.1	Registers and register transfers: Registers and load enable, register transfers, register transfer operations	2	Nil
4.2	Shift registers, Design of Ripple counter, Johnson Counter, Ring counter	3	Nil
4.3	Design of synchronous binary counters, other counters	3	Nil
Module – 5: Memory and Programmable Logic			
5.1	Memory and Programmable Logic, Random-Access Memory, Memory Decoding	2	Nil

5.2	Read-Only Memory, Programmable Logic Array, Programmable Array Logic	2	Nil
5.3	Sequential Programmable Devices, Rapid prototyping of Digital Systems using FPGA.	4	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

List of Experiments:

Sl. No.	Experiment	Hands on/ Virtual
1	Simulation and realisation of Boolean expressions using logic gates	Hands on
2	Study of 3 to 8 decoder, priority encoder and 8×1 multiplexer	Hands on
3	Design and realisation of binary adders and subtractors	Hands on
4	Verification of truth tables of Flip-flops	Hands on
5	Design and realisation of up-down counter	Hands on
6	Design and realisation of Ripple counter	Hands on
7	Design and realisation of Ring counter, Johnson Counter	Hands on
8	Design and realisation of serial adder	Hands on
9	HDL Simulation of combinational circuits and rapid prototyping with FPGAs	Hands on
10	HDL Simulation of sequential circuits and rapid prototyping with FPGAs	Hands on

Textbooks:

1. M Morris Mano **"Digital Design with an Introduction to the Verilog HDL, VHDL, and System Verilog"**, Sixth Edition, Pearson Publication, 2017.

Reference Books:

1. John M Yarbrough, **"Digital Logic Applications and Design",** Thomson Learning, 1997.

Course Code: BEE303
Credits: 3
L:T:P:S - 3:0:0:0
SEE Hours: 3 Hrs

Course Name: Electrical Machines
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To discuss electromagnetic fundamentals and winding configurations 2. To develop proficiency in DC machine operation, control methods and testing procedures 3. To have insight into transformer principles, conduct performance analysis and demonstrate three-phase connection methods.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss the fundamental principles and concepts of Electrical Machines.	Understand
CO2	Apply knowledge about testing and applications of DC machines and transformers	Apply
CO3	Model electrical machines under steady-state conditions and analyse their performance	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	1		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Fundamentals of Electric Machines		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Magnetic circuits – series and parallel, leakage flux and fringing, B-H curve, Hysteresis loss	2	Nil
1.2	Electromagnetic Induction, production of torque by the alignment of two fields	2	Nil
1.3	Components of Electric Machines, Armature windings – Single layer and double layer windings, lap and wave windings	4	Nil
Module – 2: DC Machines - I			
2.1	DC machines as generator and motor, Flux distribution in the air gap, EMF equation	1	Nil
2.2	Classification of DC Machines – Shunt, series, compound wound, permanent magnet DC machine, Equivalent circuit of DC machines.	2	Nil
2.3	Armature reaction in DC Machines, Demagnetising and Cross magnetising ampere turns, Commutation process and use of Interpoles	3	Nil
2.4	Losses in DC Machines, calculation of efficiency (Related Numerical problems)	2	Nil
Module – 3: DC Machines - II			
3.1	DC Generators – Magnetisation characteristics, Process of voltage build up	1	Nil
3.2	DC Motors – Back emf, Torque Equations and Torque-speed Characteristics (Related Numerical problems)	2	Nil
3.3	Starting Methods of DC motors, Dynamic braking and plugging	2	Nil
3.4	Speed control Methods for DC Motors (Related Numerical problems)	2	Nil
3.5	Testing of DC Machines – Swinburne's test, Hopkinson's test, Field Test, Retardation test	2	Nil
Module – 4: Transformers - I			
4.1	Ideal and real transformers, dot convention, magnetising current, saturation, inrush current and harmonics in transformers	2	Nil
4.2	Development of equivalent circuit of transformer and its approximation	2	Nil
4.3	Phasor Diagram for No-load and On-Load Single phase transformers.	2	Nil
4.4	Losses in transformer and Determination of efficiency (Related Numerical problems)	2	Nil
Module – 5: Transformers - II			
5.1	Voltage regulation, expression of voltage regulation at different power factors, condition for maximum voltage regulation (Numerical problems)	2	Nil

5.2	Testing of transformers – OC and SC tests, Sumpner's test	2	Nil
5.3	Parallel Operation of Single-phase transformers	1	
5.4	Tap changing in transformers, saving of copper	1	Nil
5.5	Transformer connection for three phase operation – star/star, delta/delta, star/delta, zigzag/star and V/V, choice of connection, scott connection	2	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Nagrath and Kothari, **"Electrical Machines",** 4th edition, TMH, 2010.
2. Dr.P.S.Bhimbra, **"Electrical Machines",** 7th edition, Khanna Publishers, 2006.

Reference Books:

1. Langsdorf A S, **"Theory of DC Machinery"**, McGraw Hill, 1999
2. Say M G, **"The Performance and Design of AC Machines"**, CBS, 1983.

Course Code: BEE304
Credits: 4
L:T:P:S - 3:2:0:0
SEE Hours: 3 Hrs

Course Name: Analog Electronics
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To develop proficiency in MOSFET operation principles and protection circuits through numerical analysis and DC circuit applications. 2. To develop skills in MOSFET amplifier design and frequency response analysis using small-signal models. 3. To demonstrate op-amp applications and limitations via circuit implementations and numerical problem-solving.

Course Outcomes:

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

COs		Bloom's level
CO1	Describe the fundamental principles and working of MOSFET and Op-Amp based circuits	Understand
CO2	Determine various parameters for a given electronic circuit	Apply
CO3	Design and analyse various electronic circuits	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-		3	-	-

Mapping Strength: Strong – 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to MOSFET and switching circuits		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Working principle, V-I characteristics of MOSFET and their applications, Numerical problems.	02	Nil
1.2	Breakdown and input protection, MOSFET circuits at DC	03	02
1.3	MOSFET Digital Switching	02	Nil
Module – 2: MOSFET Amplifier			
2.1	MOSFET as an Amplifier and as a switch	01	Nil
2.2	Large signal operation- Transfer characteristics, Graphical derivation	02	Nil
2.3	Operation as a Linear amplifier	02	Nil
2.4	Biasing in MOS Amplifier circuits	02	02
Module – 3: Frequency Response of MOSFET Amplifier			
3.1	Small signal operation and models	02	Nil
3.2	Basic MOSFET Amplifier configurations	02	Nil
3.3	The MOSFET Internal capacitances & High frequency models	02	Nil
3.4	Frequency response of CS Amplifier	02	02
3.5	Frequency response of CD and CG Amplifier	02	Nil
Module – 4: Operational Amplifiers -I			
4.1	Ideal and practical Op-Amps, offset voltages and currents, input and output impedance, slew rate and frequency limitations, Op-Amp classification.	01	Nil
4.2	Op-Amp circuits –biasing Op-Amps, voltage follower	02	Nil
4.3	Op-Amp circuits – inverting and non-inverting amplifiers, Comparators, Summing Amplifiers	02	Nil
4.4	Op-Amp circuits – integrators and differentiators, Numerical problems	03	02

Module – 5: Operational Amplifiers -II			
5.1	Schmitt trigger design	03	Nil
5.2	Limiting circuits, Sample and hold circuits.	02	02
5.3	Astable and monostable multivibrators using 555 Timer.	02	Nil
5.4	Phase-shift and quadrature oscillators – circuits and design.	01	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		10

Textbooks:

1. Adel S. Sedra, Kenneth C. Smith, "**Microelectronic Circuits- Theory and Applications**" 6th edition, Oxford University press, 2017
2. David A Bell, **" Electronic Devices and Circuits",** 5th edition, Oxford; 2016.

Reference Books:

1. Robert L. Boylestad and Louis Nashelsky, **"Electronic Devices and Circuit Theory",** 9th edition, PHI/Pearson Education, 2006.

Course Code: BEEL305
Credits: 1
L:T:P - 0:0:2
SEE Hours: 3 Hrs

Course Name: Electrical Machines Lab
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. Develop hands-on experience of conducting various tests on DC machines and transformers 2. Demonstrate various methods for the performance analysis of dc machines and transformers

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Conduct various tests on DC machines and transformers and analyse the results	Analyse
CO2	Demonstrate various methods and evaluate the performance of dc machines and transformers	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	3	3	-	1		3	-	1
CO2	3	2	3	-	-	-	-	-	3	3	-	1		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

List of experiments

Sl. No.	**Experiment**	**Hands on/ Virtual**
1	Speed Control of DC Shunt Motor using Armature voltage and field resistance control method.	Hands on
2	Speed control of DC Shunt motor using Ward Leonard method	Hands on
3	Predetermination of Efficiency and Regulation of single-phase transformers using OC and SC Test	Hands on
4	Predetermination of Efficiency and Regulation of single-phase transformers using Sumpner's Test	Hands on
5	Determination of Rotational losses of DC machines using Retardation Test.	Hands on
6	Predetermination of Efficiency of DC shunt machine using Hokinson's Test	Hands on
7	Predetermination of Efficiency of DC shunt machine using Swinburne's Test	Hands on
8	Predetermination of Efficiency of DC series machine using Field Test	Hands on
9	Scott Connection	Hands on
10	Parallel operation of two dissimilar transformers	Hands on

Reference Books:

1. Dr.P.S.Bhimbra, **"Electrical Machines",** 7th edition, Khanna Publishers, 2006.
2. Nagrath and Kothari, **"Electrical Machines",** 4th edition, TMH, 2010.
3. BHEL **"Transformer"** 2nd Edition,TataMc-Graw Hill publishing Pvt Ltd, 2003

Course Code: BSCK307
Credits: 1
L:T:P:S – 0:0:2:0
SEE Hours: -

Course Name: Social Connect & Responsibility
CIE: 100% Marks
SEE: -
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To make students understand and appreciate the important societal/ environmental issues like conservation/ sustainability/ waste management and the like and inculcate ethical responsibility towards the same. 2. Provide a formal platform for students to communicate and connect to their surroundings and enable them to have a responsible connection with society.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Understand social responsibility	Understand
CO2	Practice sustainability and creativity	Apply
CO3	Demonstrate planning and organizational skills	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	1	3	1	1	-	2		-	-	3
CO2	-	-	-	-	-	2	1	3	2	2	-	2		-	-	3
CO3	-	-	-	-	-	2	1	3	3	3	-	1		-	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1		**No. of Lecture Hours**	**No. of Tutorial Hours**	**No. of Practical Hours**
1.1	**Plantation and adoption of a tree:** Plantation of a tree that will be adopted for four years by a group of B.E. students. They will also make an excerpt either as a documentary or a photoblog describing the plant's origin, its usage in daily life, and its appearance in folklore and literature. **OR** **Heritage walk and crafts corner:** Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsmen, photo blog and documentary on evolution and practice of various craft forms.	1	Nil	4
Module – 2				
2.1	**Organic farming and waste management:** usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus. **OR** **Food Walk:** City's culinary practices, food lore, and indigenous materials of the region used in cooking.	1	Nil	4
Module – 3				
3.1	**Water Conservation:** knowing the present practices in the surrounding villages and implementation in the campus, documentary or photo blog presenting the current practices	1	Nil	4
	Total No. of Lecture Hours	**3**		
	Total No. of Tutorial Hours		**Nil**	
	Total No. of Practical Hours			**12**

Activities:

Jamming session, open mic, and poetry: Platform to connect to others. Share the stories with others.

Share the experience of Social Connect: Exhibit the talent like playing instruments, singing, one-act play, art-painting, and fine art.

Pedagogy:

The pedagogy will include interactive lectures, inspiring guest talks, field visits, social immersion, and a course project.

Applying and synthesizing information from these sources to define the social problem to address and try to arrive at the solution through the course project, of your group.

Social immersion with NGOs/social sections will be a key part of the course.

Guideline for Assessment Process: Continuous Internal Evaluation (CIE)

After completion of the social connect, the student shall prepare, with daily diary as reference, a comprehensive report in consultation with the mentor/s to indicate what he has observed and learnt in the social connect period. The report should be signed by the mentor.

The course shall be evaluated based on the following criteria and/or other relevant criteria pertaining to the activity completed / based on the rubrics approved by the DC.

Components	Marks
Marks allotted for the diary	10
Planning and scheduling the social connect	05
Information/Data collected during the social connect-	10
Analysis of the information/data and report writing	15
Final presentation	10
Total	**50**

Engineering Science Course
(ESC/ETC/PLC)

Course Code: BEE306A
Credits: 3
L:T:P - 3:0:0
SEE Hours: 3 Hrs

Course Name: Mathematics for Signal Processing
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To discuss signal classification and system properties through mathematical definitions and analysis of time-domain behaviors 2. To develop skill in Fourier analysis techniques for signal representation across continuous/discrete domains, emphasizing transform properties and applications. 3. To demonstrate Laplace and Z-transform methods for solving differential/difference equations and analyzing system transfer functions.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss the properties and classification of signals & systems, and the time domain representation of LTI systems.	Understand
CO2	Analyse signals in frequency domain using Fourier transform, Laplace transform and Z-transform methods.	Analyse
CO3	Simulate and analyse LTI system in frequency domain.	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	1		3	-	1
CO2	3	3	-	-	-	-	-	-	-	-	-	1		3	-	1
CO3	3	3	2	-	3	-	-	-	-	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to signals and systems		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Definitions of a signal and a system, classification of signals	2	Nil
1.2	Basic operations on signals, elementary signals	3	Nil
1.3	Properties of systems	3	Nil
Module – 2: Time-domain representation of LTI systems			
2.1	Block diagram representations of LTI systems, convolution, impulse response representation, properties of impulse response	3	Nil
2.2	Differential and difference equation representations	4	Nil
Module – 3: Fourier representation of signals			
3.1	Introduction, Fourier representations for four signal classes	3	Nil
3.2	Discrete Time Fourier Series representation and FT representations, properties of Fourier representations	4	Nil
Module – 4: Representation of Signals Using Laplace Transform			
4.1	Introduction to Laplace Transform	2	Nil
4.2	The Unilateral Laplace Transform, Properties of Laplace Transform: linearity, scaling, time shift, s-domain shift, convolution, differentiation, Initial and final value theorems	3	Nil
4.3	Inversion of Laplace Transform, Transfer function in S-domain	2	Nil
4.4	Solving Differential Equations with Initial Conditions	2	Nil
Module – 5: Representation of Signals Using Z Transform			
4.1	Introduction, Z-transform, properties of ROC	2	Nil
4.2	Properties of Z-transforms: linearity, time reversal, time shift, multiplication by exponential sequence, convolution, differentiation	3	Nil
4.3	Inversion of the Z-transform, Transfer function in Z-domain	2	Nil

4.4	Solution of difference equations, Z- Transform Realization of system function	2	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Simon Haykin and Bary Van Veen, **"Signals and Systems",** John Wiley and Sons, 2008.

Reference Books:

1. Alan V Oppenheim, Alan S Wilskey and S. Hamid Movas, **"Signals and Systems",** 2 nd edition 1997, Indian Reprint 2002.
2. Michel J Roberts, **"Signal and Systems: Analysis of Signals through Linear Systems",** Tata McGraw-Hill.
3. B. P. Lathi, **"Linear Systems and Signals"**, Oxford University Press, 2005

Course Code: BEE306B
Credits: 3
L:T:P:S - 3:0:0:0
SEE Hours: 3 Hrs

Course Name: Electrical Measurements and Instrumentation
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To discuss measurement fundamentals including instrument characteristics, error analysis, and calibration techniques for industrial applications. 2. To develop proficiency in electrical measurements and mechanical measurements using both analog and digital instruments. 3. To discuss signal conditioning methods and data acquisition systems for modern instrumentation needs. 4. To develop skills to select suitable sensors and actuators, and develop and instrumentation system.

Course Outcomes:

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

COs		**Bloom's level**
CO1	Describe standards, characteristics and working principles of various measuring instruments.	Understand
CO2	Identify suitable signal conditioning circuit, transmission method and recording method.	Apply
CO3	Carry out mini project by selecting suitable sensors and actuators.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	2	-	-	3	-	-	-	-	-	-	3		3	2	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Fundamentals of measuring instruments		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Basic Terminology of measurement and instrumentation, Units and standards, Functional elements of an instrument	2	Nil
1.2	Input-output configuration, static characteristics and static calibration - least squares calibration curves - static sensitivity - linearity	2	Nil
1.3	Dynamic characteristics - dynamic response analysis - operational and sinusoidal transfer function	1	Nil
1.4	Zero, first and second-order instruments	1	Nil
1.5	Errors and handling of errors in measurement	2	Nil
Module – 2: Electrical and Electronic Measurements			
2.1	Voltage and Current measurements in AC & DC circuits- MC, MI meters, Extension of range in meters	3	Nil
2.2	Digital voltmeters and Multimeters	1	Nil
2.3	Measurement of Power and Power factor measurement using Wattmeter	2	Nil
2.4	Measurement of Energy and Industrial Metering	3	Nil
Module – 3: Temperature, Pressure, Sound, Force, Torque and Shaft power measurements			
3.1	Temperature Measurement- Thermal expansion methods, bimetallic thermometers, Digital thermometers	1	Nil
3.2	Pressure measurement – Deadweight gauges and manometers, elastic transducers, diaphragm gauges, McLeod gauge, Knudsen gauge	3	Nil
3.3	Sound measurement- microphones, pressure response, acoustic intensity, acoustic emission	2	Nil
3.4	Elastic force transducers – bonded-strain-gauge transducers, differential-transformer transducers, piezoelectric transducers	1	Nil
3.5	Torque measurement on rotating shafts	1	Nil

Module – 4: Signal Conditioning, Transmission and Recording of data			
4.1	Signal conditioning- Amplifiers, Filters, Analog to Digital converters, Digital	3	Nil
	to Analog converters		
4.2	Cable transmission, telemetry	2	Nil
4.3	Digital Storage Oscilloscope	2	Nil
Module – 5: IoT Sensing and Actuation			
5.1	Selection of sensors, Sensor Characteristics	1	Nil
5.2	Actuators, Actuator Types, Actuator Characteristics	1	Nil
5.3	IoT Architecture, Application based IoT Protocols	2	Nil
5.4	Smart sensor technology for IoT	2	Nil
5.5	Application of IoT – Smart home	2	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. E. O. Doebelin, D. N. Manik, **"Measurement systems Application and Design"**, McGraw Hill Book Company, Fifth Edition, 2007.
2. Ashish Khanna, Deepak Gupta, Purnima Lala Mehta, Victor Hugo C. de Albuquerque **"Smart Sensors for Industrial Internet of Things- Challenges, Solutions and Applications",** Springer International Publishing, 2021

Reference Books:

1. Dr. A.K. Sawhney, **"A course in electrical and electronic measurements and instrumentation"**, Dhanpat Rai Publications, 19th Edition, 2011.
2. D. Patranabis, **"Principles of Industrial Instrumentation",** Tata McGraw Hill Publishing Ltd., New Delhi, Third Edition, 2010.

Course Code: BEE306C **Course Name: Electromagnetic Fields**
Credits: 3 **CIE: 50% Marks**
L:T:P - 3:0:0 **SEE: 50% Marks**
SEE Hours: 3 Hrs **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To develop ability to apply vector calculus in analyzing static and dynamic electromagnetic fields through problem-solving exercises. 2. To have insight into Maxwell's equations and fundamental laws through theoretical explanations. 3. To discuss material-field interactions by examining dielectric and magnetic properties and applying boundary conditions to solve interface problems.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Explain the basic laws and concepts of static and time varying electric and magnetic fields.	Understand
CO2	Apply vector calculus to analyse the behaviour of static and time varying electric and magnetic fields.	Analyse
CO3	Explain the nature of dielectric and magnetic materials and apply the boundary conditions for electromagnetic problems.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-		3	-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Electrostatics		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Dot Product, Cross Product, Rectangular, Circular Cylindrical & Spherical Coordinate Systems, Del operator, Gradient, Divergence and divergence theorem, Curl, Stoke's theorem, Classification of vector fields	2	Nil
1.2	The Experimental Law of Coulomb, Electric Field Intensity, Field due to a Continuous Volume Charge Distribution	2	Nil
1.3	Field of a Line Charge, Field of a Sheet of Charge, Electric Flux Density, Gauss‟ law-Maxwell's first equation.	2	Nil
1.4	Application of Gauss‟ law: Electric field due to different charge distributions	2	Nil
Module – 2: Energy and Potential, Current and Conductors			
2.1	Energy expended in moving a point charge in an electric field, The line integral, Potential and Potential Difference, Potential gradient	3	Nil
2.2	Maxwell's second equation, The Potential field of a point charge and a System of Charges, Energy density in an electrostatic field, Current and Current Density, Continuity of current and relaxation time.	3	Nil
2.3	The electric dipole and flux lines	2	Nil
Module – 3: Electric fields in material space			
3.1	Conductors, Convection and Conduction currents, Dielectrics – Dielectric constant, strength and polarization, Resistance, Capacitance, Boundary conditions	3	Nil
3.2	Poisson's and Laplace's Equations, Uniqueness theorem, Procedure for solving Poisson's and Laplace's equations	3	Nil
3.3	Parallel plate capacitor and coaxial capacitor	2	Nil
Module – 4: Magnetostatics			
4.1	Biot-Savart's Law, Ampere's circuital law-Maxwell's third equation,	4	Nil

	Magnetic Flux and Flux Density – Maxwell's fourth equation, Scalar and Vector Magnetic Potentials.		
4.2	Magnetic forces, materials, and Inductance: Force on a Moving Charge, Force on a differential Current Element, Force between Differential Current Elements, Magnetization and Permeability, Analogy between magnetic and electric circuits	4	Nil
Module – 5: Magnetic Materials, Electromagnetism			
5.1	Classification of magnetic materials, Magnetic boundary conditions, Inductance, Magnetic energy, Magnetic circuits, Force on magnetic materials, B-H curve	4	Nil
5.2	Time-varying fields: Faraday's law, Transformer and Motional EMFs, Displacement Current, Maxwell's equations for time varying fields, Retarded potentials, Wave equation	4	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Matthew N. O. Sadiku, **"Elements of Electromagnetics",** 7th edition, Oxford University Press, 2018.
2. William H Hayt, Jr. and John A Buck, **"Engineering Electromagnetics",** 7 th edition, Tata McGraw-Hill, 2006

Reference Books:

1. David K Cheng, **"Field and Wave Electromagnetics",** 2nd edition, Pearson Education Asia, 2001.
2. John Krauss and Daniel A Fleisch, **"Electromagnetics with Applications",** 5th edition, McGraw-Hill, 1999.

Course Code: BEE306D
Credits: 3
L:T:P:S - 3:0:0:0
SEE Hours: 3 Hrs

Course Name: Semiconductor Devices
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To know about the developments and characteristics of Silicon Carbide (SiC) and Galium Nitride (GaN) devices.. 2. To understand the working, steady state and switching characteristics of current controlled and voltage-controlled silicon devices. 3. To study the working of driving circuits, protection circuits and the thermal characteristics of power devices and the ability to design heat sink for the power devices.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Explain the characteristics of Silicon Carbide (SiC) and Galium Nitride (GaN) devices.	Understand
CO2	Analyse the steady state and switching characteristics of current controlled and voltage-controlled silicon devices.	Analyse
CO3	Analyse and design driving circuits & protection circuits of power devices.	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	1	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-		3	1	-
CO3	3	3	3	-	2	-	-	-	-	-	-	2		3	1	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to Power Semiconductor Devices		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Power switching devices overview - Attributes of an ideal switch, application requirements, circuit symbols, Power handling capability	3	Nil
1.2	Power diodes - Types, forward and reverse characteristics, switching characteristics - rating.	3	Nil
1.3	SiC Diodes, SiC Schottky diodes – internal structure and features	2	Nil
Module – 2: Current Controlled Devices			
2.1	BJT's - construction, steady state and dynamic models of BJT, switching characteristics, negative temperature coefficient and second breakdown.	3	Nil
2.2	Thyristors – Construction, working, steady state and dynamic models of Thyristor, static and transient characteristics, types, series and parallel operation.	3	Nil
2.3	Comparison of BJT and Thyristor, Basics of GTO	2	Nil
Module – 3: Voltage Controlled Devices			
3.1	Principle of voltage-controlled devices, Power MOSFETs - construction, types, static and switching characteristics, steady state and dynamic models.	3	Nil
3.2	IGBTs - construction, static and switching characteristics, steady state and dynamic models.	3	Nil
3.3	Features of COOLMOS, The linear relationship between blocking voltage and on-resistance of COOLMOS.	2	Nil
Module – 4: Device selection, Driving and Protecting Circuits			
4.1	Device selection strategy – On-state and switching losses, Switching loss and conduction loss calculation for power device, Numerical on loss calculation.	2	Nil
4.2	Necessity of isolation, pulse transformer, optocoupler	2	Nil
4.3	Gate drive integrated circuit: Study of Driver IC – IRS2110/2113, SCR,	2	Nil

	MOSFET, IGBTs and base driving for power BJT		
4.4	Over voltage, over current and gate protections, Design of snubbers	2	Nil
Module – 5: Thermal Protection			
5.1	Guidance for hear sink selection – Thermal resistance and impedance, Electrical analogy of thermal components.	3	Nil
5.2	Computation of thermal resistance by the heat transfer due to conduction, convection and radiation.	3	Nil
5.3	Heat sink types and design, Mounting types	2	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Rashid M.H**., "Power Electronics Circuits, Devices and Applications "**, Pearson, 4th Edition, 10th Impression 2021.

Reference Books:

1. Ned Mohan, T.M.Undeland and W.P.Robbins, **"Power Electronics: converters, Application and design",** 3rd edition Wiley, 2007
2. Tsunenobu Kimoto and James A. Cooper , "**Fundamentals of Silicon Carbide Technology: Growth, Characterization, Devices, and Applications"**, First Edition., 2014 John Wiley & Sons Singapore Pte Ltd
3. Alex Lidow, Johan Strydom, Michael de Rooij, David Reusch, **"GaN Transistors for Efficient Power Conversion"**, Second Edition, Wiley, 2015

Course Code: BEE306E
Credits: 3
L:T:P - 3:0:0
SEE Hours: 3

Course Name: Sensors and Signal Conditioning
CIE: 50 Marks
SEE: 100 Marks
Total Marks: 100

Prerequisites if any	Nil
Learning objectives	Understanding the basic concepts and principles of different sensors and the signal conditioning circuits used for the same.

Course Outcomes:

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

COs		**Bloom's level**
CO1	Explain the principle of operation of different sensors and their applications.	Understand
CO2	Discuss the recent trends in sensor technologies.	Understand
CO3	Describe the concept of signal conditioning circuits.	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	1		3	-	1
CO2	3	-	-	-	-	-	-	-	-	-	-	1		3	-	1
CO3	3	-	-	-	-	-	-	-	-	-	-	1		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to sensor-based measurement system		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	General concepts and terminology, sensor classification.	2	Nil
1.2	Material for sensors, micro sensor technology	3	Nil
1.3	Resistive gas sensors, Liquid conductivity sensors	2	
1.4	Selection of sensor.	1	Nil
Module – 2: Reactance variation and Electromagnetic sensors			
2.1	Capacitive Sensors, Inductive Sensors, Electromagnetic Sensors	3	Nil
2.2	Signal Conditioning for Reactance Variation Sensors and Specific Signal Conditioners for Capacitive Sensors	2	Nil
2.3	Industrial applications of electromagnetic sensor	2	Nil
Module – 3: Self-generating sensors			
3.1	Thermoelectric sensors, Piezoelectric sensors	2	Nil
3.2	Pyroelectric sensors, Photovoltaic sensors, Electrochemical sensors.	3	Nil
3.3	Signal conditioning for self-generating sensors and Electrochemical sensors	3	Nil
3.4	Industrial applications of self-generating sensors	1	Nil
Module – 4: Recent developments in sensors			
4.1	Smart sensor, Intelligent sensor	2	Nil
4.2	MEMS sensor, Nano sensors	2	Nil
4.3	Design of smart sensor	2	Nil
4.4	Smart sensor technology for IoT.	2	Nil
4.5	Industrial applications of smart sensor.	1	Nil
Module – 5: Signal Conditioning			
5.1	Concept of signal conditioning, analogue-digital sampling	2	Nil
5.2	Interference, grounding, shielding, minimizing noise.	1	Nil
5.3	Plug in data acquisition board, RS-232 and RS-485 standards	3	Nil
5.4	20mA current loop. IEEE 488 standard.	1	Nil
	Total No. of Lecture Hours	**40**	
	Total No. of Tutorial Hours		**Nil**

Textbooks:

1. S Ramón Pallas-Areny, John G. Webster, **"Sensors and Signal Conditioning",** Wiley,2012.
2. Analog Devices Inc. (Norwood, Mass.), **"Practical Design Techniques for Sensor Signal Conditioning",** 1999.

Reference Books:

1. E.O. Doebelin, **"Measurement Systems – Application and Design",** Tata McGraw Hill publishing company, 2019.
2. Patranabis,D, **"Principles of Industrial Instrumentation",** 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.

Ability Enhancement Course - III

Course Code: BEE358A
Credits: 1
L:T:P:S - 0:0:2:0
SEE Hours: 2 Hrs

Course Name: Testing of Electrical Apparatus
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. Demonstrate the testing of different Electrical Apparatus accordance with IS/IEC standards

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Testing of different Electrical Apparatus accordance with IS/IEC standards	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	2	-	2	-	-	-	-	3	3	-	3		3	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	**Experiment**	**Hands on/ Virtual**
1	Introduction to IS/IEC standards, basics of Testing and Test Equipment	Hands on
2	Measurement of Earth resistance	Hands on
3	Testing of Current Transformer	Hands on
4	Testing of 3phase Energy meter	Hands on
5	Testing of Cable	Hands on
6	Testing of Capacitor	Hands on
7	Testing of LED and sodium vapour Lamps	Hands on
8	Testing of Transformer	Hands on
9	Breakdown strength test on Transformer oil	Hands on
10	Test the performance of Generator operation	Hands on

Course Code: BEE358C
Credits: 1
L:T:P:S - 0:0:2:0
SEE Hours: 2

Course Name: Electrical Hardware Laboratory
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To demonstrate the implementation of the hardware and analyse different electric circuits.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Implement the hardware and analyse different electric circuits.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	-	-	3	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

List of experiments:

Sl. No.	**Experiment**	**Hands on/ Virtual**
1.	Verification of KCL and KVL for DC Circuits.	Hands on
2.	Verification of KCL and KVL for AC Circuits.	Hands on
3.	Measurement of Current, Power and Power Factor of Incandescent Lamp, Fluorescent Lamp and LED Lamp.	Hands on
4.	Evaluate the loading effect of Voltmeter of electric circuits.	Hands on
5.	Measurement of Resistance using V-I method.	Hands on
6.	Measurement of Resistance and Inductance of a Choke coil using three voltmeter method.	Hands on
7.	Determination of Phase and Line quantities in three-phase star and delta connected loads.	Hands on
8.	Two-Way and Three-Way Control of Lamp and Formation of Truth Table.	Hands on
9.	Measurement of Earth Resistance using fall of potential method.	Hands on
10.	Determination of fuse characteristics.	Hands on

Course Code: BEE358E
Credits: 1
L:T:P:S - 1:0:0:0
SEE Hours: 2

Course Name: Electrical Safety and Risk Management
CIE: 50% Marks
SEE: 50 Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To have insight into electricity rules and standards for public safety 2. To understand the safety precautions against electrical hazards 3. To understand hazard analysis and risk assessment management

Course Outcomes:

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

COs		**Bloom's level**
CO1	Explain electricity rules and standards for public safety and apply them for the safety precautions against electrical hazards	Apply
CO2	Explain hazard analysis principles and apply for the risk assessment management	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	3	-	-	-	-	-	1		3	-	1
CO2	3	-	-	-	-	3	-	-	-	-	-	1		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Electrical Safety Standards and Precautions		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction to Electrical Safety and Safety Management: General Safety Provisions in Indian Electricity Rules, OSHA Standards on Electrical Safety, Basic Electrical Safety Rule as per OSHA	1	Nil
1.2	Hazards Associated with Electric Current and Voltage, Protection against Electrical Hazards, Types of Electrical Hazards	1	Nil
1.3	Effect of Electrical Current on the Human Body, Principles of Electrical Safety, Occurrence of Electric Shock, AC Shocks Versus DC Shocks	1	Nil
1.4	Prevention of Shocks, Safety Precautions against Contact Shocks, Flash Shocks and Burns	1	Nil
1.5	Safety Precautions in Small LV Installations, Residential Buildings, Shops, Safety Procedures in Electrical Plant	2	Nil
Module – 2: Electrical Hazard Analysis			
2.1	Electrical safety model: Recognize Hazards, Evaluate Hazards, Control Hazards	2	Nil
2.2	Shock Hazard Analysis, Regulatory Requirements, Industry-Recognized Good Practices	2	Nil
2.3	Arc Flash Hazard Analysis	1	Nil
Module – 3: Risk Assessment Management			
3.1	Risk Assessment Management: Hazard Identification, Identify the assets at risk, Impact Analysis	1	Nil
3.2	Risk matrix, Decision Tree, Failure Modes and Effects Analysis, Bowtie Model	2	Nil
3.3	Implementation of Risk Assessment Module	1	Nil
	Total No. of Lecture Hours	**15**	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. S. Rao, R K Jain and H L Saluja**, "Electrical Safety, Fire Safety Engineering and Safety Management",** Second Edition, Khanna Publishers, 2012.
2. **"Electrical Safety Program",** University of Pennsylvania, Environmental Health & Radiation Safety, 2022.

Course Code: BEE358F
Credits: 1
L:T:P - 0:0:2
SEE Hours: 2

Course Name: PCB Design using ORCAD/KiCAD
CIE: 50 Marks
SEE: -
Total Marks: 50

Prerequisites if any	Nil
Learning objectives	1. Create circuit schematics for different electronic components 2. Footprint creation, placement of components and routing in PCB

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Design of PCB for different electronic circuits using ORCAD/KiCAD software	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	-	-	3	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

List of experiments:

Sl. No.	**Experiment**	**Hands on/ Virtual**
1.	Introduction to ORCAD/KiCAD software (Initialization of new project, Exploring various features)	Hands on
2.	Creating the circuit schematics using Capture module	Hands on
3.	Understanding the aspects associated with layout (track, net via and their usage)	Hands on
4.	Preparation of schematics of circuits consisting of Digital ICs, Resistors, connectors	Hands on
5.	Preparation of schematics of circuits consisting of Linear ICs, Resistors, capacitors	Hands on
6.	Foot print creation of electronic components	Hands on
7.	Preparation of schematics of circuits consisting of Power semiconductors / SPM, Current/voltage sensors, capacitors, regulators etc.	Hands on
8.	Printed circuit board design	Hands on
9.	Placements components on PCB: Thermal management, EMI/EMC considerations	Hands on
10.	Introduction to routing on PCB	Hands on
11.	Design and routing for multilayer PCBs and usage of PCB in modern days.	Hands on

Course Code: BEE358G
Credits: 1
CIE: 100% Marks
SEE Hours: -

Course Name: Object Oriented Programming with C++
L:T:P:S - 0:0:2:0
SEE: -
Total Marks: 100

Prerequisites if any	Nil
Learning objectives	1. Emphasize the importance of Classes, Objects & Data Abstraction 2. Emphasize the importance of encapsulation, Overloading, Inheritance, Polymorphism Reusability & Exception Handling

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Apply the major object-oriented concepts to implement object	Apply
CO2	Apply advanced features of C++ specifically stream I/O, templates and operator overloading	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	1	-	-	-	3	-	-	-	-	1	-	1		-	-	3
CO2	1	-	-	-	3	-	-	-	-	1	-	1		-	-	3
CO3	1	-	-	-	3	-	-	-	-	1	-	1		-	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

List of Experiments:

Sl. No.	**Experiment**	**Hands on/ Virtual**
1	Write a program that uses a class where the member functions are defined inside a class	Hands on
2	Write a program that uses a class where the member functions are defined outside a class	Hands on
3	Write a program to demonstrate the use of static data members	Hands on
4	Write a program to demonstrate the use of constant data members.	Hands on
5	Write a program to demonstrate the use of zero argument and parameterized constructors.	Hands on
6	Write a program to demonstrate the use of dynamic constructor.	Hands on
7	Write a program to demonstrate the use of explicit constructor	Hands on
8	Write a program to demonstrate the use of initializer list	Hands on
9	Write a program to demonstrate the overloading of increment and decrement operators	Hands on
10	Write a program to demonstrate the multilevel inheritance.	Hands on

Textbooks:

1. SouravSahay**, "Object-Oriented Programming with C++",** Oxford University Press, 2006

Reference Books:

1. B JarneStroustrup, "**The C++ program language**", Pearson Education Asia
2. Stanley B. Lippman, JoseeLajoie, Barbara E. Moo, "**C++ Primer**", 4th Edition, Addison Wesley, 2005

B.E Electrical and Electronics Engineering

(2023-2027)

Syllabus – IV Semester

Department of Electrical and Electronics Engineering

The National Institute of Engineering

Mysuru-570 008

Course Code: BEE401 **Course Name: Power Electronics**
Credits: 3 **CIE: 50% Marks**
L:T:P:S - 3:0:0:0 **SEE: 50% Marks**
SEE Hours: 3 Hrs **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To discuss the operating principles of power semiconductor devices and converter topologies through circuit analysis and waveform demonstrations. 2. To develop skills in converter design and analysis techniques, including steady-state operation, switching characteristics, and power supply applications through hands-on calculations. 3. To demonstrate circuit simulation methods using tools like PSIM/MATLAB for performance evaluation of power electronic systems.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Explain the principle of operation of power electronic devices and circuits.	Understand
CO2	Analyse Power Electronic Converters and Power Supplies	Analyse
CO3	Simulate and analyse Power Electronic Circuits	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	3	2	2	3	-	-	-	-	-	-	1		3	3	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Power Semiconductor Devices		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction to Power Electronics and its Applications, Types of power semiconductor devices and their Control Characteristics	1	Nil
1.2	Types of power electronic circuits, Block diagram of a typical power converter system, Steps to design a typical power converter	2	Nil
1.3	Operating principle, V-I characteristics, specifications and switching characteristics of of SCR (Two transistor model of SCR), power MOSFET and IGBT	3	Nil
1.4	Turn-on and turn-off of SCR (natural and forced commutation)	2	Nil
1.5	Gate drive circuits for power MOSFETs and IGBTs, Snubber circuits, Isolation of gate and base drives	2	Nil
Module – 2: AC-DC Converters (Controlled Rectifiers)			
2.1	Classification of rectifiers, principle of operation	1	Nil
2.2	Single- phase half-wave converter and full converter, Derivation of average and rms output voltage expressions, Numerical problems	4	Nil
2.3	Three-phase half-wave converter and full converter (qualitative analysis only, derivations and harmonic analysis excluded)	2	Nil
2.4	Simulation of controlled rectifiers using P-SIM/MATLAB software.	1	Nil
Module – 3: DC-DC Converters			
3.1	Analysis of step down and step-up chopper with R and RL load	2	Nil
3.2	Switching mode regulators, Principle of operation and design of Buck, Boost and Buck- Boost voltage regulators, Numerical problems	4	Nil
3.3	Simulation of DC-DC regulators using P-SIM/MATLAB software.	1	Nil
Module – 4: DC-AC Converters (Inverters)			
4.1	Introduction, Principle of operation of single-phase half-bridge and full-bridge inverter, three phase full bridge inverters (180^0 conduction only)	3	Nil

4.2	Voltage control of single-phase inverters – pulse amplitude modulation (PAM) and pulse width modulation (PWM) techniques	4	Nil
4.3	Generation of PWM pulses using single PWM, multiple PWM and sinusoidal PWM methods, Computation of fundamental component of inverter output voltage using Fourier series analysis.	1	Nil
Module – 5: AC-AC Converters, DC Power Supplies			
5.1	AC-AC Converters: Introduction, Principle of ON-OFF control and phase control of AC voltage controllers	1	Nil
5.2	Simulation and analysis of single-phase half wave and full wave ac voltage controllers with resistive and inductive loads.	1	Nil
5.3	DC Power Supplies: Principle of operation and analysis of fly back converter, forward converter, push-pull converter, half bridge converter, full bridge converter and resonant converter, Numerical problems.	5	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Muhammad H. Rashid, **"Power Electronics Devices, Circuits, and Applications"**, fourth edition, Pearson Education Limited, England, 2014.

2. L Umanand, "**Power Electronics, Essentials and Applications**", 1st Edition, Wiley India Pvt. Ltd., 2009

Reference Books:

1. Robert W Erickson, Dragan Maksimovic, "**Fundamentals of Power Electronics**", Third edition, Springer Nature, 2020.
2. P.S.Bimbra, **"Power Electronics"**, fourth edition, Khanna Publishers, New Delhi, 2006.

Course Code: BEE402
Credits: 4
L:T:P:S - 3:0:2:0
SEE Hours: 3 Hrs

Course Name: Analysis of Electrical Machines
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To have insight into the construction details and fundamental principles of induction machines and synchronous machines 2. To demonstrate various tests on induction machines and synchronous machines for the performance evaluation 3. To derive the models of induction machines and synchronous machines under steady state 4. To have hands-on experience on various tests and methods on induction machines and synchronous to evaluate their performance

Course Outcomes:
On the successful completion of the course, the student will be able to

Cos		**Bloom's level**
CO1	Describe the fundamental principles of induction machines and synchronous machines	Understand
CO2	Analyse the performance of induction machines and synchronous machines	Analyse
CO3	Model induction machines and synchronous machines under steady state and analyse their performance	Analyse
CO4	Conduct various tests on induction machines and synchronous and analyse the results	Analyse

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	3	-	-	-	-	-	-	3	3	-	2		3	-	2
CO4	3	2	2	-	-	-	-	-	3	3	-	3		3	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Three-phase Induction Machines - I		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Rotating magnetic field, production of torque, Phasor diagram, Torque Equations and Slip-Torque Characteristics (Related Numerical Problems).	2	Nil
1.2	Equivalent circuit of Induction Motor, Power Flow in Three phase Induction Motor	2	Nil
1.3	Single phasing, effect of air gap flux harmonics, cogging and crawling,	1	Nil
1.4	Deep bar and double cage rotors	1	Nil
1.5	Principle of operation of Induction Generator	1	Nil
Module – 2: Three-phase Induction Machines - II			
2.1	Starting methods – DOL starting - auto transformer starting - star delta starting - rotor resistance starting	3	Nil
2.2	Speed control methods - voltage control - frequency control - rotor resistance control - pole changing	3	Nil
2.3	No-load and blocked rotor tests - performance evaluation, circle diagram (Related Numerical Problems).	3	Nil
Module – 3: Single-phase induction motors			
3.1	Principle of Operation of Single-phase Induction Motor – Two Reaction theory, equivalent circuit	2	Nil
3.2	Starting methods and types of Single-phase Induction Motors and their applications.	3	Nil
3.3	Working of linear Induction Motors, reluctance motors, universal motors, shaded pole motors	2	Nil

Module – 4: Synchronous Machines - I			
4.1	AC armature windings, winding factors, EMF equation of alternator	1	Nil
4.2	Armature reaction, Effective resistance and synchronous reactance, Equivalent circuit (Related Numerical Problems)	2	Nil
4.3	OCC & SCC Test, SCR and its Significance, Determination of Voltage Regulation of Non-Salient pole Alternators using EMF, MMF and ZPF Methods (Numerical Problems)	3	Nil
4.4	Blondel two reaction theory for salient pole machine with phasor diagram, Slip test for the determination of X_d and X_q of a salient pole alternator.	2	Nil
4.5	Armature reaction, Effective resistance and synchronous reactance, Equivalent circuit (Related Numerical Problems)	2	Nil
Module – 5: Synchronous Machines - II			
5.1	Power output of salient pole and Non-Salient Pole generator with their Power angle characteristics (Related Numerical problems)	2	Nil
5.2	Synchronising power and torque, Parallel Operation of Alternators, Infinite Bus bar and Synchronization	2	Nil
5.3	Synchronous Motor (qualitative treatment only) - Principle of operation, Starting, Hunting of Synchronous Motor and significance of Damper Windings	2	Nil
5.4	Effect of load on synchronous motors (Numerical Problems), Effect of change in excitation of synchronous motors, V-curves and Inverted V-curves.	1	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

List of experiments:

Sl. No.	Experiment	Hands on/ Virtual
1	Load Test on Three phase Induction Motor	Hands on
2	Load test on single-phase induction motor	Hands on
3	Starting of Three phase Induction Motor	Hands on
4	Speed Control of Three phase Induction Motor using Y-Δ	Hands on
5	Speed Control of Three phase Induction Motor using VFD	Hands on
6	Performance Evaluation of Induction motors using Circle Diagram	Hands on
7	Voltage Regulation using EMF and MMF Method	Hands on
8	Voltage Regulation using ZPF Method	Hands on
9	V and Inverted V Curve of Synchronous Motor	Hands on
10	Determination of Xd and Xq of Salient Pole Alternator using Slip test	Hands on

Textbooks:

1. P.S. Bhimbra, **"Electrical Machines"**, 7th edition, Khanna Publishers, 2006.
2. V K Mehta and Rohit Mehta, **"Principles of Electrical Machines"**, 2nd edition, S. Chand Publishing, 2019.

Reference Books:

1. Nagrath and Kothari, **"Electrical Machines"**, 4th edition, TMH, 2010

Course Code: BEE403
Credits: 4
L:T:P:S - 3:2:0:0
SEE Hours: 3 Hrs

Course Name: Electrical Network Analysis
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To familiarize the basic laws, source transformations, network theorems and the methods of analyzing electrical circuits. 2. To explain the concept of resonance and to analyze three-phase circuits 3. To explain the importance of initial conditions, their evaluation and transient analysis of R-L and R-C circuits. 4. To familiarize the analysis of two port networks.

Course Outcomes:

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

COs		Bloom's level
CO1	Apply basic laws and theorems and analyze the steady state and transient behaviour of electrical networks	Analyze
CO2	Analyze resonant and three phase circuits	Analyze
CO3	Compute two-port network parameters and discuss their applications	Apply
CO4	Conduct investigations on complex electrical networks by using appropriate software tools.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-		3	-	-
CO4	3	3	2	2	3	-	-	-	2	-	-	2		3	3	2

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Methods of analysing circuits-1		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Independent versus dependent sources and source conversions	2	Nil
1.2	Mesh and nodal analysis (applied to both DC and AC circuits)	4	1
1.3	Super position theorem to DC and AC circuits	2	1
Module – 2: Methods of analysing circuits-2			
2.1	Thevenin's theorem to DC and AC circuits	3	1
2.2	Norton's theorem to DC and AC circuits	2	Nil
2.3	Maximum Power Transfer theorems to DC and AC circuits	3	1
Module – 3: Resonant and three-phase circuits			
3.1	Series and parallel resonant circuits	2	1
3.2	Three phase balanced and unbalanced circuits	1	Nil
3.3	Star-Delta and Delta-Star conversions	1	1
3.4	Coupled circuits	2	Nil
Module – 4: Transient response of networks			
4.1	General and particular solutions, Time constants and integrating factor	1	Nil
4.2	Initial conditions in circuit elements and its evaluation	1	Nil
4.3	Solution of second-order equations: Networks with internal excitation (DC Circuits)	2	1
4.4	Solution of networks excited by external energy sources	2	1

4.5	Waveform synthesis: step, ramp and impulse functions	2	Nil
4.6	Applications of Convolution theorem in electric circuits	2	Nil
Module – 5: Two-Port Networks			
5.1	Characterization of LTI two-port networks	1	Nil
5.2	Open-circuit and short-circuit parameters and their applications	2	1
5.3	Transmission parameters, Hybrid parameters and their applications	2	1
5.4	Interrelationships between the parameters	2	Nil
5.5	Interconnection of two-port networks	1	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		10

Textbooks:

1. M.E.Van Valkenburg, **"Network Analysis"**, 3rd Edition, Prentice Hall of India publication, 2008.
2. A Sudhakar, Shyammohan S Palli, **"Circuits and Networks"**, 2 nd edition, McGraw-Hill Publication.
3. W.H.Hayt, J. Kemmerly **"Engineering Circuit Analysis",** 7 th edition, McGraw-Hill Publication.

Reference Books:

1. Vincent Del Toro, **"Electrical Engineering Fundamentals",** Prentice Hall Publications.
2. H Cotton, **"Electrical Technology",** CBS Publishers & Distributors, 2004.
3. Durgesh C. Kulshreshtha, Gopal G. Bhise, Prem R. Chadha, **"Engineering Network Analysis and Filter Design",**Umesh Publications, 2012.
4. K. S Sureshkumar**, "Electric Circuits and Networks",** Dorling Kindersly (India) Pvt. Ltd., 2009.

Open Courseware:

1. nptel.ac.in/courses/108102042/

Course Code: BEEL404
Credits: 1
L:T:P:S - 0:0:2:0
SEE Hours: 2 Hrs

Course Name: Power Electronics Lab
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To demonstrate the operating characteristics of power semiconductor devices (diodes, thyristors, MOSFETs, IGBTs) through experiments. 2. To develop skills in simulation and analysis of power electronic converters (AC-DC, DC-DC, DC-AC) using industry-standard software tools. 3. To demonstrate practical implementation of power electronic circuits through hands-on experiments with hardware modules.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Analyse the characteristics of various power electronic devices.	Analyse
CO2	Simulate and analyze various power electronic circuits.	Analyse
CO3	Demonstrate the working of various power electronic circuits using the hardware modules.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	3	3	-	3		3	-	3
CO2	3	2	2	-	-	-	-	-	3	3	-	3		3	-	3
CO3	3	2	2	-	-	-	-	-	3	3	-	3		3	-	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

List of experiments:

Sl. No.	**Experiment**	**Hands on/ Virtual**
1.	Conduct experiment and plot the V-I characteristics of SCR.	Hands on
2.	Conduct experiment and plot the V-I characteristics of IGBT and MOSFET.	Hands on
3.	Turn-on SCR using RC firing circuit.	Hands on
4.	AC voltage controller using TRIAC-DIAC using the hardware module.	Hands on
5.	Single-phase controlled rectifier with R and RL Load using the hardware module.	Hands on
6.	Speed control of separately excited DC motor using single-phase semi converter.	Hands on
7.	Simulate and analyse Buck, Boost and Buck-Boost regulators.	Hands on
8.	Single-phase PWM inverter using the hardware module.	Hands on
9.	Simulate and analyse three-phase controlled rectifiers.	Hands on
10.	Simulate and analyse three-phase controlled inverters.	Hands on

Reference Books:

1. Muhammad H. Rashid, **"Power Electronics Devices, Circuits, and Applications"**, fourth edition, Pearson Education Limited, England, 2014.
2. Robert W Erickson, Dragan Maksimovic, "**Fundamentals of Power Electronics**", Third edition, Springer Nature, 2020.
3. P.S.Bimbra, **"Power Electronics"**, fourth edition, Khanna Publishers, New Delhi, 2006.

Course Code: BBOE407
Credits: 3
L:T:P:S - 3:0:0:0
SEE Hours: 3 Hrs

Course Name: Biology for Engineers
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To familiarise the structure and function of various biological systems and patient monitoring systems 2. To provide insight into the importance of Genetic Engineering and its applications 3. To familiarise the application of Biology in Engineering

Course Outcomes:
On the successful completion of the course, the student will be able to

Cos		Bloom's level
CO1	Describe the structure and function of various biological systems and patient monitoringsystems	Understand
CO2	Explain the importance of Genetic Engineering and its applications	Understand
CO3	Explain the application of Biology in Engineering	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	1	2	-	-	-	-	-	1		3	-	1
CO2	3	-	-	-	1	2	-	-	-	-	-	1		3	-	1
CO3	3	-	-	-	1	2	-	-	-	-	-	1		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Biological systems		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction	1	Nil
1.2	Origin of Life, Evolution	1	Nil
1.3	Cell: The Basic Unit of Life, Cell Cycle and Cell Division.	2	Nil
1.4	Chemical composition of Living Forms.	2	Nil
1.5	Significance of lipids, carbohydrates, proteins and nucleic acids in the Human Body	2	Nil
Module – 2: Human Organ Systems			
2.1	Tissues-Cellular and Extracellular Matrix Details	2	Nil
2.2	Physiological systems of the human body – cardiovascular system, respiratorysystem, nervous system, digestive system, reproductive system	6	Nil
Module – 3: Cell Replication and Its Quantification			
3.1	DNA Replication in a Cell—Part of the Cell Cycle, Steps in a Cell Cycle	3	Nil
3.2	Quantification of Cell Division, Chromosomes in the Cell	3	Nil
3.3	Germ cell - mitosis and Meiosis	2	Nil
Module 4: Patient Monitoring Systems			
4.1	Introduction to patient monitoring systems - cardiac monitor, bedside patient monitor,central monitor (Block diagram approach)	3	Nil
4.2	Measurement of heart rate, pulse rate, blood pressure, temperature and respiration rate	3	Nil
4.3	Intelligent medical systems	2	Nil
Module – 5: Genetic Engineering			
3.1	Introduction to Genetics - Genes and genetic materials (DNA & RNA) present inliving organisms	2	Nil
3.2	Genetic disorders	2	Nil
3.3	Genetic Engineering and its application	2	Nil

Textbooks:

1. **"Biology for Engineers: As per Latest AICTE Curriculum"**, Wiley Editorial, 2018.

2. R. S. Khandpur, **"Biomedical Instrumentation Technology and Applications",** Tata Mcgraw-hill PublishingCompany Ltd New Delhi, 2003.
3. G. K. Suraishkumar, **"Biology for Engineers",** Oxford University Press, 2019.

Reference Books:

1. Meyers, RA, **"Molecular Biology and Biotechnology: A Comprehensive Desk Reference**", Wiley, 1995.
2. Sohini Singh and Tanu Allen, **"Biology for Engineers",** Vayu Education of India, New Delhi, 2014.

Course Code: BUHK408
Credits: 1
L:T:P:S - 1:0:0:0
SEE Hours: 1 Hr

Course Name: Universal Human Values & Professional Ethics
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings. 2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. 3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with nature

Course Outcomes:
On the successful completion of the course, the student will be able to

Cos		Bloom's level
CO1	Understand the core aspirations of all human beings	Understand
CO2	Gain the universal human values and movement towards value-based living in a natural way	Apply
CO3	Fulfill the human behavior and mutually enriching interaction with nature	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	-	-	-	-	-	3	1	2	3	3	1	2		-	-	2
CO2	-	-	-	-	-	3	2	2	3	3	1	2		-	-	2
CO3	-	-	-	-	-	3	2	2	3	3	1	2		-	-	2

S – Strong (3) M – Medium (2) L – Low (1)

Course Structure

Module – 1: Introduction - Need, Basic Guidelines, Content and Process for Value Education		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Understanding the need, basic guidelines, content and process for Value Education	1	Nil
1.2	Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration	1	Nil
1.3	Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority	1	Nil
1.4	Method to fulfill the above human aspirations: understanding and living in harmony at various levels . Practice session	2	Nil
Module – 2: Understanding Harmony in Myself, Family, Society and Human Relationship			
2.1	Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha	1	Nil
2.2	Understanding Harmony in the family – the basic unit of human interaction. Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship	1	Nil
2.3	Understanding the meaning of Vishwas and Samman; Difference between intention and competence; respect and differentiation; Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals	1	Nil
2.4	Visualizing a universal harmonious order in society- Undivided Society (Akhand	2	

	Samaj), Universal Order (SarvabhaumVyawastha)- from family to world family! Practice session		Nil
Module – 3: Understanding Harmony in the Nature, Existence and Implications of the all Holistic on Professional Ethics			
3.1	Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature recyclability and self-regulation in nature	1	Nil
3.2	Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space.	1	Nil
3.3	Competence in professional ethics: a) Ability to utilize the professional competence for augmenting universal human order b) Ability to identify and develop appropriate technologies and management patterns for above production systems.	1	Nil
3.4	Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations. Practice session	2	Nil
	Total No. of Lecture Hours	15	
	Total No. of Tutorial Hours		Nil

Guidelines and Content for Practice Sessions

Practice Session 1:

Introduce yourself in detail. What are the goals in your life? How do you set your goals in your life? How do you differentiate between right and wrong? What have been your achievements and shortcomings in your life? Observe and analyze them.

Expected outcome: The students start exploring themselves; get comfortable to each other and to the teacher and start finding the need and relevance for the course.

Practice Sessions 2:

1. a. Observe that any physical facility you use, follows the given sequence with time: Necessary & tasteful→ unnecessary & tasteful → unnecessary & tasteless → intolerable b. In contrast, observe that any feeling in you is either naturally acceptable or not acceptable at all. If naturally acceptable, you want it continuously and if not acceptable, you do not want it any moment!
2. List down all your activities. Observe whether the activity is of 'I' or of Body or with the participation of both 'I' and Body.

Expected outcome:

1. The students are able to see that all physical facilities they use are required for a limited time in a limited quantity. Also they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment.
2. The students are able to see that activities like understanding, desire, thought and selection are the activities of 'I' only, the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing througbody.es, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body

Practice Session3:

Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are:

1a. Do I want to make myself happy?
2a. Do I want to make others happy?
3a. Does the other want to make him happy?
4a. Does the other want to make me happy?

What is the answer? Intention (Natural Acceptance)

1b. Am I able to make myself always happy?
2b. Am I able to make others happy?
3b. Is the other able to make him always happy?
4b. Is the other able to make me always happy?

What is the answer? Competence

Let each student answer the questions for himself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention & competence as well as the others' intention & competence.

Expected outcome:

The students are able to see that the first four questions are related to our Natural Acceptance i.e. Intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally

evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person.

Textbooks:

1. R.R Gaur, R Sangal, G P Bagaria, **"A foundation course in Human Values and professional Ethics"**, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2.

References:

1. IIT Delhi, Modern Technology – the Untold Story

Engineering Science Course
(ESC/ETC/PLC)

Course Code: BEE405A
Credits: 3
L:T:P:S - 3:0:0:0
SEE Hours: 3 Hrs

Course Name: Introduction to VLSI Circuits
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To familiarise MOS transistor fundamentals and logic implementation through MOSFET-based circuit analysis and design principles. 2. To develop skills in evaluating MOSFET electrical characteristics and CMOS gate performance using analytical and simulation tools. 3. To demonstrate VLSI subsystem design methodologies while addressing system-level constraints and optimization techniques.

Course Outcomes:
On the successful completion of the course, the student will be able to

Cos		**Bloom's level**
CO1	Understand the fundamental concepts of VLSI and MOS transistors and logic implementation using MOSFETs	Understand
CO2	Analyze the electrical characteristics of MOSFETs and evaluate CMOS logic gate performance	Analyse
CO3	Apply VLSI design principles to develop subsystems and evaluate system-level considerations	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3	-	-	3	-	-	-	-	-	-	-		3	2	-
CO3	3	3	2	-	3	-	-	-	-	-	-	-		3	2	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to VLSI and Logic design with MOSFETS		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction to VLSI Technology, Moore's Law, Design Flow, Importance of CMOS.	1	Nil
1.2	Logic Design with MOSFETs: Ideal switches and Boolean operations and MOSFETs as switches – pass characteristics	1	Nil
1.3	CMOS Inverter, Basic and Complex logic gates in CMOS and related Problems	3	Nil
1.4	Transmission gate circuits. Clocking and Dataflow control	3	Nil
Module – 2: Fabrication Technology and Circuit Design process			
2.1	Material Preparation, Fabrication Process: Thermal Oxidation, Ion Implantation and Lithography	3	Nil
2.2	nMOS Fabrication, CMOS Fabrication	2	Nil
2.3	BiCMOS Technology and Process Flow	1	Nil
2.4	Fabrication of resistors and capacitors	1	Nil
2.5	Stick diagrams	1	Nil
2.6	Design Rules and Layout, Designing FET Arrays, Basic Gate designs	2	Nil
Module – 3: Electrical Characteristics of MOSFETs and Analysis of CMOS Logic Gates			
3.1	Electrical Characteristics of MOSFETs: Operation of nMOS and Threshold Voltage,	2	Nil
3.2	nFET I-V equations, FET RC model	2	Nil
3.3	Electronic Analysis of CMOS Logic Gates: DC characteristics of CMOS inverter, Inverter switching characteristics, Power dissipation – SPICE Simulations	3	Nil
3.4	DC Characteristics and transient response of NAND and NOR gates - SPICE Simulations	2	Nil
Module – 4: The Design of VLSI Subsystems			
4.1	Introduction	2	Nil
4.2	General VLSI subsystems: Multiplexers, Latches and Flipflops	2	Nil
4.3	Arithmetic Circuits in CMOS VLSI: Bit Adder Circuits and Multipliers	2	Nil
4.4	Memories and Programmable Logics: SRAMs and Dynamic RAMS	2	Nil
Module – 5: Key Topics in VLSI System Design, Clocking, and Reliability			

5.1	Interconnect Delay Modeling, Power Distribution and distribution, Floor planning and Routing	2	Nil
5.2	CMOS Clocking Styles ,Clock Generation and Distribution	1	Nil
5.3	Reliability and Testing of VLSI Circuits	1	Nil
5.4	Pipelined Systems	1	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. John P.Uyemura, John Wiley, “Introduction to VLSI Circuits and Systems”, John Wiley & Sons,2002.
2. Kumar, V.G. K., & Nagesh, H. R. (2011). Introduction to VLSI Design. Dorling Kindersley (India) Pvt Ltd

Reference Books:

1. Sung-Mo Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits-Analysis and Design”, 4th Edition, McGraw-Hill, 2015.
2. Neil H. E. Weste, David Money Harris, “Principles of CMOS VLSI Design- A Circuits and Systems Perspective”, Pearson Education, 2015

Course Code: BEE405B
Credits: 3
L:T:P:S - 3:0:0:0
SEE Hours: 3 Hrs

Course Name: ARM Microcontrollers
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To familiarize the basic hardware components and their selection method based on the characteristics and attributes of an Embedded System. 2. To learn the architectural features and instructions of 32-bit ARM Cortex M3 microcontroller. 3. To demonstrate the interfacing of various Sensors, Actuators & Interfacing Modules with ARM processors and controllers Boards using programming exercises.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss ARM Processor fundamentals and Communication protocols.	Understand
CO2	Interface switches, Buzzer, LCD, Keypad, Motors, and Sensors with ARM microcontroller.	Analyze
CO3	Write programs using Instruction Set of ARM Microcontrollers and Embedded C to perform the tasks.	Analyze
CO4	Implement and Demonstrate Mini Projects using ARM Microcontrollers	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-		3	3	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-		3	3	-
CO4	3	3	3	2	3	-	-	-	3	-	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: ARM Embedded Systems and ARM Processor fundamentals:		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction to Microprocessors, Microcontrollers and Embedded Systems, ARM Technology Overview and Design Philosophy	2	Nil
1.2	ARM Processor Families, ARM Processor Embedded System Hardware and Software, ARM Memory Mapping	2	Nil
1.3	ARM Processor Modes, ARM Registers Set, ARM Core Data Flow Model	2	Nil
1.4	Stack Operation, Pipeline-Characteristics, Exceptions, Interrupts and Vector Table.	2	Nil
Module – 2: ARM Processor Instruction Sets and Programming:			
2.1	Data Processing Instructions, Data Transfer Instructions	2	Nil
2.2	Control Flow Instructions, Conditional Execution	2	Nil
2.3	Introduction to THUMB, Differences between ARM and THUMB	1	Nil
2.4	Bit-Banding, General Structure of ARM Assembly Module and Assembler Directives	1	Nil
2.5	ARM ALP Example Programs	2	Nil
Module – 3: ARM Microcontroller Peripherals and Programming:			
3.1	GPIOs Configuration, Timers, SysTick Timers, Watch Dog Timers	2	Nil
3.2	NVIC Controller, PWMs, RTC, PLL	2	Nil
3.3	DAC, ADC	2	Nil
3.4	Embedded C Example Programs	2	Nil
Module – 4: ARM Microcontroller Communication Protocols and Programming			
4.1	UARTs and Wireless Communication Protocols	2	Nil

4.2	I2C, SPI Protocols	2	Nil
4.3	CAN Protocols all Communication Protocols with Specification, Configuration and Modules	2	Nil
4.4	Embedded C Example Programs	2	Nil
Module – 5: ARM Microcontroller Interfacing and Programming:			
5.1	Interfacing of: Switches, Buzzer, Seven Segment Display	2	Nil
5.2	LCD (4-bit, 8-bit Mode), Keypad (4*4)	2	Nil
5.3	DC Motor, Stepper Motor, Servo motor	2	Nil
5.4	Relay, Ultrasonic Sensor, Temperature, Humidity, Soil Moisture Sensor, PIR sensor	2	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Joseph Yiu**, "The Definitive Guide to ARM Cortex M3"**, 2nd Edition.
2. Andrew N Sloss, Dominic Symes, Chris Wright, "**ARM System Developer's Guide"**,
3. LPC17XX User Manual

Reference books:

1. Steve Furber, Addison Wesley, **"ARM System-On-Chip Architecture"**, Pearson Education, 2nd edition.
2. William Hohl, Christopher Hinds, **"ARM ASSEMBLY LANGUAGE Fundamentals and Techniques",** 2nd Edition, CRC Press, 2015.
3. **ARM Assembly Language an Introduction,** Gibson Second Edition, 2007.

Course Code: BEE405C **Course Name: Communication Engineering**
Credits: 3 **CIE: 100 Marks**
L:T:P - 3:0:0 **SEE: 100 Marks**
SEE Hours: 3 Hrs **Total Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To familiarize fundamental electronic communication concepts, demonstrating AM/FM modulation principles through waveform analysis and practical examples. 2. To provide insight into digital communication systems by demonstrating sampling techniques, encoding methods, and transmission protocols using software-defined radio applications. 3. To develop proficiency in modern communication technologies through case-study demonstrations of 5G, IoT, and satellite systems, giving students hands-on insight into emerging standards.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Describe the fundamental concepts of electronic communication, AM and FM.	Explain
CO2	Discuss the principles of digital communication and digital data transmission.	Apply
CO3	Discuss the communication technologies	Apply

Mapping with POs and PSOs:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-		3	-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to Electronic Communication		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Communication system, types of electronic communication	3	Nil
1.2	Modulation and multiplexing, electromagnetic spectrum, bandwidth, gain, attenuation, decibels, tuned circuits, filters	5	Nil
Module – 2: Amplitude and Frequency modulation			
2.1	Amplitude Modulation: AM concepts, modulation index and percentage of modulation, AM power, single sideband modulation, Basic principles of AM, AM modulators and demodulators.	4	Nil
2.2	Basic principles of FM, principles of phase modulation, modulation index and sidebands, frequency modulators and demodulators	4	Nil
Module – 3: Digital Communication Techniques, Radio transmitter and Receiver			
3.1	Digital data transmission, parallel and serial transmission, data conversion, pulse modulation, digital signal processing	3	Nil
3.2	Transmitter fundamentals, carrier generators, impedance matching networks	3	Nil
3.3	Principles of signal reproduction, super heterodyne receivers, frequency conversion, Noise, Power Amplifiers	2	Nil
Module – 4: Digital Data Transmission and Optical communication			
4.1	Digital Data Transmission: Digital codes, principles of digital transmission, transmission efficiency	3	Nil
4.2	Modem and broadband concepts, wideband modulation, error detection and correction	3	Nil
4.3	**Optical communication:** Optical principles, optical communication systems, fiber optic cable, optical transmitter and receiver, protocols	2	Nil

Module – 5: Communication Technologies			
5.1	Satellite Communication: Satellite orbits, satellite communication systems, satellite subsystems, ground station, and satellite application	3	Nil
5.2	**Telecommunication system**: Telephone, Telephone system, Internet telephony	3	Nil
5.3	**Cell Phone technologies:** Cellular telephone system, 2G and 3G digital cell phone systems, long term evolution and 4G systems	2	
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Louis E. FrenzelJr, **"Principles of communication systems",** Tata-McGraw Hill Publications, 4th Edition, 2014

Course Code: BEE405D **Course Name: Distributed Generation and Microgrid**
Credits: 3 **CIE: 50% Marks**
L:T:P:S - 3:0:0:0 **SEE: 50% Marks**
SEE Hours: 3 Hrs **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To familiarize with fundamental distributed generation (DG) technologies and microgrid architectures through comparative analysis of renewable/non-renewable systems. 2. To demonstrate the components, configurations, and real-world applications of DG-microgrid systems using case studies from industrial/commercial implementations. 3. To provide operational insight into control strategies for islanded/grid-connected microgrids, including power management and stability considerations.

Course Outcomes:
On the successful completion of the course, the student will be able to

Cos		**Bloom's level**
CO1	Discuss the fundamental concepts of different DG technologies and Microgrid.	Understand
CO2	Describe different components, types and application of DG technologies	Understand
CO3	Discuss the components, composition and operating modes of Microgrid.	Understand

Mapping with POs and PSOs:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	2	-	-	-	-	-		3	-	1
CO2	3	-	-	-	-	2	2	-	-	-	-	-		3	-	1
CO3	3	-	-	-	-	2	2	-	-	-	-	-		3	-	1

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Distributed Energy Resources:		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction to distributed generation- definition, features, operation, technologies, advantages and disadvantages	3	Nil
1.2	Comparison of DG technologies, Grid integration of DG.	3	Nil
Module – 2: Solar energy and PV technology			
2.1	Introduction, solar radiation, materials and semiconductors, PV materials.	3	Nil
2.2	Electrical characteristics, PV components and standards	3	Nil
2.3	PV power systems and technologies, Materials for future PV systems.	3	Nil
Module – 3: Basic principles of wind farms			
3.1	Wind turbines- size, application, technology, components,	3	Nil
3.2	Wind power calculation, wind turbine power characteristics curve, stall and pitch control, MPPT.	3	Nil
3.3	SCIGs and DFIGs in WEGS, Grid code requirements, Synchronous generator wind turbine.	3	Nil
Module – 4: Microturbine and Fuel cell generation power systems			
4.1	Gas turbines, **Microturbine**- components, applications, types, construction and operation.	3	Nil
4.2	**Fuel cells**: principles and application of FCs, voltage losses and their roles in designing a FC.	3	Nil
4.3	Applying FCs in DG systems, Power electronic interface for MT and FCs.	2	Nil
Module – 5: Microgrid			
5.1	Definition, technical challenges in Microgrid, basic components of Microgrid.	4	Nil

5.2	Composition, structure, operation modes, classification, Integration voltage class	4	Nil
	Total No. of Tutorial Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Gevork B. Gharehpetian, S. Mohammad Mousavi Agah, **"*Distributed Generation Systems- Design, Operation and Grid Integration"***, Elsevier Inc, 2017.
2. Ruisheng Li, Fengquan Zhou, ***"Microgrid Technology and Engineering Application"***, Elsevier Inc, 2016.

Course Code: BEE405E **Course Name: Probability and Statistics**
Credits: 3 **CIE: 50% Marks**
L:T:P:S - 3:0:0:0 **SEE: 50% Marks**
SEE Hours: 3 Hrs **Max. Marks: 100**

Prerequisites if any	Nil
Learning objectives	1. To understand the concepts of random variables and their probability distributions. 2. To extract maximum information about the population by examining the samples of the population

Course Outcomes:
On the successful completion of the course, the student will be able to

Cos		**Bloom's level**
CO1	To solve problems associated with discrete and continuous probability distributions of one or more variables	Apply
CO2	To study skewness and kurtosis for a given data and use the method of least squares to fit curves for a given data and solve problems on correlation and regression	Apply
CO3	To test the hypothesis for sampling distributions	Apply

Mapping with POs and PSOs:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	1		3	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1		3	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	1		3	-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Foundations of Probability		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Probabilistic models and basic terminology	2	Nil
1.2	Conditional probability and independence events	2	Nil
1.3	Mutually exclusive vs. independent events	2	Nil
1.4	Total Probability and Bayes' theorem	1	
1.5	Fundamental counting principles	1	Nil
Module-2: Random Variables & Discrete Distributions			
2.1	Random variable concepts and PMFs	2	Nil
2.2	Mathematical expectation calculations	2	Nil
2.3	Moment generating functions	1	Nil
2.4	Binomial distribution applications	1	Nil
2.5	Poisson process modeling	1	Nil
2.6	Distribution selection for real-world problems	1	Nil
Module-3: Continuous and joint probability distribution			
3.1	Continuous random variables & PDF's, Cumulative distribution functions	2	Nil
3.2	Normal distributions	2	Nil
3.3	Central limit theorem	1	Nil
3.4	Two dimensional Random variables: Joint probability distributions	3	Nil
Module-4: Statistics			
4.1	Moments, skewness from third moment	2	Nil
4.2	Measure of skewness by Karl Pearson's, Kurtosis.	3	Nil
4.3	Curve fitting- Straight line and Exponential curves-y=ab^x	2	Nil
4.4	Correlation, Regression	2	Nil
Module-5: Sampling theory			
5.1	Population and Sampling, Sampling distributions, Statistical estimation	2	Nil

5.2	Statistical Decisions: Type I and Type II errors	2	Nil
5.3	Level of Significance, One-tailed tests, ***t*-distribution**	3	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. B.S. Grewal, **"Higher Engineering Mathematics",** 42nd edition, Khanna Publications, 2012.
2. Paul L Meyer, **"Introductory probability and statistical applications",** Oxford and IBH publishing Co. Pvt. Ltd, New Delhi

Reference Books:

1. H. K. Dass, **"Advanced Engineering Mathematics",** Chand Publications, 2007
2. B. V. Ramana, **"Higher Engineering Mathematics",** Tata McGraw-Hill Publications, 2006.
3. Peter O Neil, Thomas, **"Advanced Engineering Mathematics",** Broks/ Cole, 7th Edition.
4. Erwin Kreyszig, **"Advanced Engineering Mathematics",** wiley publications, 10th edition.
5. Ganesh Rao and Sathish Tunga, **"Signals and systems",** Cengage publications.

Ability Enhancement Course – IV

Course Code: BEE456A
Credits: 1
L:T:P:S - 0:0:2:0
SEE Hours: 2 Hrs

Course Name: Circuit Laboratory using PSPICE/LTSPICE
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To demonstrate the simulation and analysis of electric circuits using PSPICE software

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Simulate and analyse electric circuits using PSPICE/LTSPICE software	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	-	-	3	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	**Experiment**	**Hands on/ Virtual**
1	Simulation and analysis of electric circuits using mesh and nodal analysis techniques	Hands on
2	Simulation and analysis of electric circuits using superposition theorem	Hands on
3	Simulation and analysis of electric circuits using maximum power transfer theorem	Hands on
4	Simulation and analysis of electric circuits using Thevenin's and Norton's theorems	Hands on
5	Simulation and analysis of series and parallel resonance circuits	Hands on
6	Simulation of transient and parametric analysis of series RLC circuit using step and pulse Input	Hands on
7	Simulation of transient and parametric analysis of series RLC circuit using sinusoidal input	Hands on
8	Simulation and determination of Z, Y, ABCD and h parameters of a given network.	Hands on
9	Simulation and measurement of active power for star and delta connected balanced loads	Hands on
10	Simulation measurement of reactive power for star and delta connected balanced loads	Hands on

Course Code: BEE456B
Credits: 1
L:T:P:S - 0:0:2:0
SEE Hours: 2 Hrs

Course Name: ARM Microcontrollers Programming
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To provide insight into the development of Assembly language Program using ARM Cortex M3 Microcontroller instruction set 2. To demonstrate the interfacing of various Motors, Sensors and other Interfacing Modules with ARM Cortex M3 based LPC17XX

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Develop an assembly level language program for ARM CortexM3 based LPC17xx Microcontroller using Keil software tool.	Analyze
CO2	Design and implement Embedded System applications using Embedded C language for ARM CortexM3 based LPC17xx Microcontroller.	Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	2	1	-	3	-	-	-	3	3	-	3		3	3	3
CO2	3	3	3	2	3	2	-	-	3	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	**Experiment**	**Hands on/ Virtual**
	PART A	
Develop and demonstrate the following operation with the help of a suitable program in ALP using ARM Cortex M3 Evaluation board and the required software tool		
1	Data transfer operations	Hands on
2	Arithmetic operations	Hands on
3	Logical operations	Hands on
4	Code Conversions	Hands on
	PART B	
1	Interface a simple Switch and display its status through Relay, Buzzer and LED.	Hands on
2	Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in between.	Hands on
3	Interface a 4x4 keyboard and display the key code on an LCD.	Hands on
4	Interface DC Motors, Stepper Motor, and Servo Motor rotate clockwise, anticlockwise and in angle (45^o, 90^o, 180^o).	Hands on
5	Generate different delay using Timers and count external pulses using counters	Hands on
6	Generate an Interrupt process and demonstrate the use of an external interrupt to toggle an LED On/Off.	Hands on
7	Using the Internal PWM module of ARM controller generate PWM and vary its duty cycle to Speed Control of DC motor and to change the intensity of Light.	Hands on
8	Generate non-sinusoidal and sinusoidal waveforms with variable amplitude and frequency using internal DAC.	Hands on
9	Display output for given analog input using internal ADC. (Use of Analog Sensors like Ultrasonic Sensor, Temperature, Humidity, Soil Moisture Sensor, PIR sensor)	Hands on
10	Interface Bluetooth Module, GPS module, GSM module, RF module and RFID cards to send & receive Data using internal UARTs.	Hands on

Course Code: BEE456C
Credits: 1
L:T:P:S - 0:0:2:0
SEE Hours: 2

Course Name: Design and Fabrication of Electronic Circuits
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To familiarize with signal conditioning fundamentals by demonstrating protection circuit design for sensor interfaces and electrical measurement systems. 2. To develop proficiency in electronic circuit design through hands-on implementation of analog/digital solutions for industrial applications (power supplies, motor drives, IoT devices). 3. To provide insight into real-world problem solving by analyzing case studies and prototyping circuits that address actual engineering challenges.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Design and implement signal conditioning and protection circuits for electrical applications.	Create
CO2	Develop and implement electronic circuits to solve a real-world problem	Create

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO2	3	2	3	-	3	-	-	-	3	3	-	3		3	2	3
CO4	3	2	3	-	3	-	-	-	3	3	-	3		3	2	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

List of experiments:

Sl. No.	**Experiment**	**Hands on/ Virtual**
1.	Design, Simulation and testing of summing amplifier circuit using op-amps.	Hands on
2.	Design, Simulation and testing of differentiator circuit using op-amps.	Hands on
3.	Design, Simulation and testing of integrator circuit using op-amps.	Hands on
4.	Design, Simulation and testing of R-2R DAC using op-amps.	Hands on
5.	Design, Simulation and testing of flash ADC using op-amps.	Hands on
6.	Interfacing a 5V ON/OFF control signal from a digital circuit to energize a contactor rated to carry a current of 100A (by soldering)	Hands on
7.	Wiring a circuit to trip a contactor with interlocking circuits (trip on overload, over voltage, over temperature)	Hands on
8.	Design and simulate amplifier circuits using operational amplifiers to amplify signals from Hall effect current and voltage sensors.	Hands on
9.	Solder and test amplifier circuits using operational amplifiers to amplify signals from Hall effect current and voltage sensors.	Hands on
10.	Generating a trip signal using a comparator circuit IC with level/Hysteresis setting features.	Hands on

Textbooks:

1. Thomas L Floyd, **"Electronic Devices",** 10th edition, Pearson Education, Inc Publishers, 2017.
2. David A Bell, **" Electronic Devices and Circuits",** 5th edition, Oxford; 2016.

Course Code: BEE456D
Credits: 1
L:T:P:S - 0:0:2:0
SEE Hours: 2 Hrs

Course Name: Selection of Power Converter Components
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To familiarize with power electronic components and circuit implementation 2. To develop proficiency in power converter design 3. To provide hands-on insight into complete power electronics product development

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Selection and implementation of various types of power electronic converters	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1	1	-	3	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Sl. No.	**Experiment**	**Hands on/ Virtual**
1	Identification of components, reading data sheets and understanding their specifications	Hands on
2	Arrangement and assembly of components as per the circuit diagram on the Printed circuit boards	Hands on
3	Preparing the schematics using KiCAD/OrCAD assembly of Buck/Boost converter power circuits	Hands on
4	Computation and Observation of current /voltage waveforms through/across the power devices	Hands on
5	Design and implementation and assembly of gate drive circuits for MOSFET/IGBT	Hands on
6	Design power circuits for simple converters Buck/Boost/Inverter for the given specifications	Hands on
7	Selection of power components i.e. IGBT/MOSFET/Capacitors/Chokesfor the given voltage/current/Operating frequency/duty cycles	Hands on
8	Planning the power/control circuit layout for the given converter design	Hands on
9	Preparing the BOM, Sourcing of components and building the Power converter	Hands on
10	Testing, performance analysis, waveform recording and result tabulation for Power converter built in Exercise-9	Hands on

Course Code: BEE456E
Credits: 1
L:T:P:S - 0:0:2:0
SEE Hours: 2

Course Name: Introduction to Verilog /VHDL coding
CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. To implement digital systems in FPGA using VERILOG/VHDL coding

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Implement digital systems in FPGA using Verilog/VHDL	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	-	-	3	3	-	3		3	3	3

Mapping Strength: Strong– 3 Medium – 2 Low – 1

List of experiments:

Sl. No.	**Experiment**	**Hands on/ Virtual**
1.	Implementation of basic logic gates using VERILOG and verification of their function through simulation.	Hands on
2.	Implementation of Decoders using VERILOG and verification of their function through simulation.	Hands on
3.	Implementation of Encoders using VERILOG and verification of their function through simulation.	Hands on
4.	Implementation of Multiplexers using VERILOG and verification of their function through simulation.	Hands on
5.	Implementation of Logical shifters using VERILOG and verification of their function through simulation.	Hands on
6.	Implementation of flip flops using VERILOG and verification of their function through simulation.	Hands on
7.	Design and implement a Four-bit Adder using VERILOG defining its Structural Description	Hands on
8.	Design and implement a Four-bit Up/Down Counter using VERILOG	Hands on
9.	Design and implement a Ring counter using VERILOG	Hands on
10.	Design and implement a Johnson counter using VERILOG	Hands on
11	Implementation of 7 segment displays using VERILOG and verification of their function through simulation.	Hands on