COURSE STRUCTURE

B. TECH.
ELECTRICAL & ELECTRONICS ENGINEERING

Under

Choice Based Credit System (CBCS)

PROGRAM STRUCTURE
EN-1400

Sr. No.	Categorization	Credits
1	Humanities & Social Sciences	25
2	Basic Sciences	24
3	Engineering Sciences	28
4	Project Work / Seminars	17
5	Program Core	48
6	Program Electives	26
7	Open Electives	16
8	Non Graded Mandatory Courses	8(2 credits in each sem.)
	Total Credits	186/192(Including MNC)

Project Work / Seminars	Mini Project	4 = (1+3)
	Industrial Training	2
	Minor Project	3
	Major Project	8

First Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1.	BMAS0101	Engineering Mathematics –	3	1	0	4	4
2.	BELH0001	English Language Skills For Communication I	1	2	0	2	3
3.	BPHS0001	Engineering Physics	3	1	0	4	4
4.	BMEG0001	Basic Mechanical Engineering	3	1	0	4	4
5.	BEEG1001	Basic Electrical	3	1	0	4	4
PRACTICALS							
6.	BEEG0800	Electrical Engineering Lab	0	0	2	1	2
7.	BMEG0801	Engineering Drawing	0	0	2	1	2
8.	BELH0801	English Language Lab I	0	0	2	1	2
9.	BMEG0801 /BMEG080	Engineering Drawing/Workshop	0	0	2	1	2
10.	BPHS0801	Engineering Physics Lab	0	0	2	1	2
		Total	15	6	14	23	33

Second Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1.	BMAS 0102	Engineering Mathematics – II	2	0	0	4	2
2.	BELH 0002	English Language Skills For Communication – II	1	2	0	2	3
3.	BCHS 0101	Engineering Chemistry	3	1	0	4	3
4.	BCSC 0001	Computer Programming	3	2	0	5	4
5.	BECG	Electronics Engineering	3	1	0	4	4
6.	BEEG 0003	Electrical Measurement & Measuring Instruments	3	0	0	3	3
PRACTICALS							
7.	BEEG 0803	Electrical Measurement Lab	0	0	2	1	2
8.	BECG	Electronics Lab – I	0	0	2	1	2
9.	BCSC 0800	Computer programming lab	0	0	2	1	4

10.	BELH 0802	English Language Lab – II	0	0	2	1	2
11.	BCHS 0801	Engineering Chemistry Lab	0	0	2	1	2
		TOTAL	15	1	10	27	34

Program Core

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J			
THEORY									
1.	BEEC1003	Engineering Circuit Analysis & Synthesis	3	1	0	0	4	4	-
2.	BEEC000	Field Theory &	3	0	0	0	3	3	-
3.	BEEC101	Signals & Systems	3	1	0	0	4	4	-
4.	BEEC0020	Analog & Digital Electronics	3	0	0	0	3	3	-
5.	BEEC0021	Analog & Digital Communication	3	0	0	0	3	3	-
6.	BEEC000	Electrical Machines – I	3	0	0	0	3	3	
7.	BEEC0010	Electrical Machines – II	3	0	0	0	3	3	
8.	BEEC101	Control System	3	1	0	0	4	4	
9.	BEEC0018	Power System Transmission & Distribution	3	0	0	0	3	3	
10.	BEEC0019	Power System Analysis & Protection	3	0	0	0	3	3	
11.	BEEC1014	Power Electronics	3	1	0	0	4	4	
12.	BEEC0015	Microprocessor & Its Applications	3	0	0	0	3	3	
PRACTICALS									
13.	BEEC080	Network Lab	0	0	2	0	1	2	BEEC000
14.	BEEC080	Analog & Digital	0	0	2	0	1	2	BEEC000
15.	BEEC0806	Electrical Machines Lab – I	0	0	2	0	1	2	BEEC0009
16.	BEEC0807	Electrical Machines Lab – II	0	0	2	0	1	2	BEEC0010
17.	BEEC080	Control System Lab	0	0	2	0	1	2	BEEC001
18.	BEEC0812	Power System & Protection Lab	0	0	2	0	1	2	BEEC0013
19.	BEEC081	Power Electronics Lab	0	0	2	0	1	2	BEEC001
20.	BEEC0811	Microprocessor Lab	0	0	2	0	1	2	BEEC0015

Total	**36**	**4**	**16**	**0**	**48**	**56**	

Program Elective

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
Bouquet: Power System & Machines									
THEORY									
1.	BEEE0030	Electrical Power Generation	3	0	0	0	3	3	
2.	BEEE0036	Intelligent Techniques In Electrical Engineering	3	0	0	0	3	3	
3.	BEEE0034	Power System Operation & Control	3	1	0	0	4	4	
4.	BEEE0031	High Voltage Engineering	4	0	0	0	4	4	
5.	BEEE0032	Smart Grid	3	0	0	0	3	3	
6.	BEEE0072	Electric Drives	3	0	0	0	3	3	
7.	BEEE0071	Special electric Machines	3	0	0	0	3	3	
8.	BEEE0078	utilization of electric power & traction	3	1	0	0	4	4	
9.	BEEE0076	Electric Vehicles	3	1	0	0	4	4	
PRACTICALS									
10.	BEEE0851	Intelligent Techniques In Electrical Engineering Lab	0	0	2	0	1	2	BEEE 0036
11.	BEEE0870	Electric Drives Lab	0	0	2	0	1	2	BEEE0072
PROJECTS									
12.	BEEJ0966	Electric Vehicles Project	0	0	0	8	2	8	

Program Elective

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
Bouquet: Renewable Technologies									
THEORY									
1.	BEEE0090	Introduction to Renewable Energy Technologies	3	0	0	0	3	3	
2.	BEEE0099	Design & Installation of Solar PV System	3	1	0	0	4	4	
3.	BEEE0095	Solar Energy System	3	0	0	0	3	3	
4.	BEEE0094	Wind Energy Conversion System	3	0	0	0	3	3	
PRACTICALS									
5.	BEEE0881	Solar Energy System Lab	0	0	2	0	1	2	BEEE0095
6.	BEEE 0882	Design & Installation of Solar PV System Lab	0	0	2	0	1	2	BEEE 0099
PROJECTS (IF EXIST)									
7.	BEEJ0972	Design & Installation of Solar PV System Project	0	0	0	8	2	8	BEEE0099

Program Elective

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
Bouquet: Instrumentation & Control									
THEORY									
1.	BEEE0050	Sensors & Transducers	3	0	0	0	3	3	
2.	BEEE0056	PLC & SCADA	3	0	0	0	3	3	
3.	BEEE0052	Advance Control System	3	0	0	0	3	3	CS
4.	BEEE0053	Biomedical Instrumentation	3	0	0	0	3	3	
5.	BEEE0054	Process Control & Advanced Instrumentation	4	0	0	0	4	4	EMMI & CS
6.	BEEE0055	Digital Control System	3	1	0	0	4	4	
7.	BEEE0051	Optimal Control System	3	0	0	0	3	3	CS
PRACTICALS									
8.	BEEE0860	Process Control & Advanced Instrumentation Lab	0	0	2	0	1	2	BEEE0054
9.	BEEE0861	PLC & SCADA Lab	0	0	2	0	1	2	BEEE0056
PROJECTS (IF EXIST)									
10.	BEEJ0961	PLC Based Project	0	0	0	4	1	4	BEEE0056

Program Elective

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
Bouquet: Energy Systems									
THEORY									
8.	BEEE0090	Introduction to Renewable Energy Technologies	3	0	0	0	3	3	
9.	BEEE0099	Design & Installation of Solar PV System	3	1	0	0	4	4	
10.	BEEE0100	Illumination Science & Engineering	3	1	0	0	4	4	
11.	BEEE0095	Solar Energy System	3	0	0	0	3	3	
12.	BEEE0094	Wind Energy Conversion System	3	0	0	0	3	3	
PRACTICALS									
13.	BEEE0881	Solar Energy System Lab	0	0	2	0	1	2	BEEE0095
14.	BEEE 0882	Design & Installation of Solar PV System Lab	0	0	2	0	1	2	BEEE 0099
PROJECTS (IF EXIST)									
15.	BEEJ0972	Design & Installation of Solar PV System Project	0	0	0	8	2	8	BEEE0099

Program Elective

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
Bouquet: Electronics & Embedded System									
THEORY									
1.	BEEE0112	Digital Signal Processing	3	1	0	0	4	4	
2.	BEEE0110	Biomedical Signal Processing	3	0	0	0	3	3	
3.	BEEE0111	Analog & Digital Communication	3	0	0	0	3	3	
4.	BEEE0115	Medical Image Processing	4	0	0	0	4	4	
5.	BEEC0007	Analog Integrated Circuit	3	0	0	0	3	3	-
6.	BEEC0015	Microprocessor & Its Applications	3	0	0	0	3	3	
PRACTICALS									
7.	BEEE 0890	Medical Image Processing Lab	0	0	2	0	1	2	BEEE 0890
8.	BEEC0811	Microprocessor Lab	0	0	2	0	1	2	BEEC0015

Projects (J)

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
1.	BEEJ0950	Mini Projects - I	0	0	0	4	1	4	
2.	BEEJ0951	Mini Project - II	0	0	0	12	3	12	
3.	BEEJ0953	Minor Project	0	0	0	12	3	12	
4.	BEEJ0955	Major Project	0	0	0	32	8	0	
5.	BEEJ0991	Industrial Training	0	0	4	0	2	0	
		TOTAL	**0**	**0**	**0**	**60**	**17**		

Mandatory Non Graded Course (M)

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
THEORY									
1.	BCSM0001	Introduction to Cyber Security	2	0	0	0	0	2	
2.	BCHM0101	Disaster Management	2	0	0	0	0	2	
3.	MBAM0001	Basic Course in Entrepreneurship	2	0	0	0	0	2	
4.	MBAM0002	Leadership And Organizational Behavior	2	0	0	0	0	2	
		TOTAL	**8**	**0**	**0**	**0**	**0**	**8**	

Humanities and Social Sciences (H)

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J			
THEORY									
1.	BELH0001	English Language Skills for Communication – I	2	0	0	0	2	2	
2.	BELH0002	English Language Skills for Communication – II	2	0	0	0	2	2	
3.	BELH0003	English for Professional Purpose – I	2	0	0	0	2	2	
4.	BELH 0004	English for Professional Purpose – II	2	0	0	0	2	2	
5.	BELH0006	Ethics & Values	2	0	0	0	2	2	
6.	MBAC0005	Industrial Management	3	0	0	0	3	3	
PRACTICALS									
7.	BELH0801	English Language Lab – I	0	0	2	0	1	2	
8.	BELH0802	English Language Lab – II	0	0	2	0	1	2	
9.	BTDH0301	Soft Skills – I	0	0	2	0	1	2	
10.	BTDH 0302	Soft Skills – II	0	0	2	0	1	2	
11.	BTDH0303	Soft Skills – III	0	0	8	0	4	4	
12.	BTDH0304	Soft Skills – IV	0	0	8	0	4	4	
TOTAL			**13**	**0**	**24**	**0**	**25**	**37**	

Basic Sciences (S)

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
THEORY									
1.	BMAS0101	Engineering Mathematics I	3	1	0	0	4	4	
2.	BMAS0102	Engineering Mathematics II	3	1	0	0	4	4	
3.	BMAS0103	Engineering Mathematics III	3	1	0	0	4	4	
4.	BCHS0101	Engineering Chemistry	3	1	0	0	4	4	
5.	BPHS0001	Engineering Physics	3	1	0	0	4	4	
6.	BCHS0201	Environmental Studies	2	0	0	0	2	2	
PRACTICALS									
7.	BCHS0801	Engineering Chemistry Lab	0	0	2	0	1	2	
8.	BPHS0801	Engineering Physics Lab	0	0	2	0	1	2	
TOTAL			**17**	**5**	**4**	**0**	**24**	**26**	

Engineering Sciences (G)

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
THEORY									
1.	BEEG1001	Basic Electrical Engineering	3	1	0	0	4	4	
2.	BECG0001	Electronics Engineering	3	1	0	0	4	4	
3.	BMEG0001	Basic Mechanical Engineering	3	1	0	0	4	4	
4.	BEEG0002	Electrical Technology	3	0	0	0	3	3	
5.	BCSC0001	Computer Programming	4	1	0	0	5	5	
PRACTICALS									
6.	BEEG0800	Electrical Engineering Lab	0	0	2	0	1	2	
	BEEG0801	Electrical Simulation Lab	0	0	4	0	2	4	
7.	BEEG0802	Electrical technology Lab	0	0	2	0	1	2	
8.	BECG0800	Electronics Lab I	0	0	2	0	1	2	
9.	BMEG0800	Engineering Workshop Practice Lab	0	0	2	0	1	2	
10.	BMEG0801	Engineering Drawing Lab	0	0	2	0	1	2	
11.	BCSC0800	Computer Programming Lab	0	0	2	0	1	2	
TOTAL			16	4	14	0	28	16	

Open Elective (Offer to other Departments)

S. NO.	CODE	SUBJECT	TEACHING SCHEME				CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J			
THEORY									
1.	BEEO0090	Electrical Machine & Automatic Control	3	0	0	0	3	3	
2.	BEEO0092	Non-Conventional Energy Resources	4	0	0	0	4	4	
PRACTICALS									
3.	BEEO0900	Electrical Machines & Automatic Control Lab	0	0	2	0	1	2	BEEO0090

BEEG 1001: BASIC ELECTRICAL ENGINEERING

Credits: 04 **L-T-P-J:3-1-0-0**

Module No.	Content	Teaching Hours
I	**DC circuit analysis & Network theorems:** Fundamentals of electric circuits, Kirchhoff's laws, mesh analysis, nodal analysis, Thevenin's theorem, maximum power transfer theorem, superposition theorem. **Steady state AC analysis:** AC fundamentals, average &rms values of different AC waveforms, phasor algebra, analysis of series AC circuits, power triangle, concept of power factor. **Three phase AC circuits:** Generation & advantages of three phase system, star & delta connection, line & phase voltage/current relations.	20
II	**Magnetic circuits:** Faraday's law, circuit analysis, analogy between magnetic and electric circuit, magnetic hysteresis. **Single phase Transformers:** Constructional feature, Working Principle, EMF equation, Ideal transformer, Equivalent Circuit, Phasor diagram, parameter evaluation using O.C & S.C test, efficiency, voltage regulation. **Rotating Electrical Machines:** **DC Machine:** Construction, operating principle, Need of Starter, EMF Equation, Types of DC Motor, Torque Equation, Torque-speed Characteristics and applications. **Induction motor:** 3-phase: Construction & Principle, Need of Starter, Torque Equation, Torque-slip Characteristics. **Single Phase Induction motor:** Principle and Starting methods.	22

Text Book:

- D.C. Kulshrestha, "Basic Electrical Engineering", Tata McGraw Hill.

Reference Books:

- T.K. Nagsarkar&M.S.Sukhija, "Basic Electrical Engineering", Oxford University Press.
- H. Cotton, "Advanced Electrical Technology", 2nd Edition, Wheeler Publishing.
- I. J. Nagarath, "Basic Electrical Engineering", 4th Edition, Tata McGraw Hill.
- D. E. Fitzgerald & A. Grabel Higginbotham, "Basic Electrical Engineering", 5th Edition, McGraw Hill.
- Edward Hughes, "Electrical Technology", 3rd Edition, Pearson Education.

Focus: This course focuses on Employability aligned with all COs.

Course Outcome: *After completion of course, students will be able to:*

1. Define the basic concept of active & passive elements, Linear & non-linear elements, Unilateral and Bilateral Elements, Ideal & Practical voltage and current sources.
2. Illustrate the working principle of various machines like DC Machine, and Induction motor.
3. Classify DC motors and induction motors.
4. apply the concept of KVL/KCL, Thevenin's theorem, Super position Theorem and Maximum power transfer theorem to solve the electrical circuits.
5. Compute the parameters of single phase and three phase AC electrical circuits, magnetic circuit and transformer.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PSO1, PSO2
CO2	PO1, PO2, PO3, PO4, PSO1, PSO2
CO3	PO1, PO2, PO3, PO4, PSO1, PSO3
CO4	PO1, PO2, PO3, PO4, PSO2, PSO3
CO5	PO1, PO2, PO3, PO4, PSO2

BEEG0800: ELECTRICAL ENGINEERING LAB

Credits: 01 **L–T–P-J: 0–0–2-0**

Module No.	Content	Teaching Hours
I, & II	1. To Verify the Thevenin's Theorem (DC Circuits). 2. To Verify the Maximum Power Transfer Theorem (DC Circuits). Also Draw Graph between Power and Load Resistance. 3. To Verify the Superposition Theorem (DC Circuits). 4. To Study the Phenomenon of Resonance in R-L-C Series Circuit and to Draw Graph Between Frequency and Current. Also Show Half Power Points. 5. To Determine the V-I Characteristics of a Semiconductor Diode. Also Calculate Forward and Reverse Static and Dynamic Resistances. 6. To Study the Half Wave and Full Wave (Center Tapped) Rectifier With and Without Filter. Also to Calculate the Ripple Factor in Both Cases (Without Filter). 7. To Study Single Phase (Induction Type) Energy Meter. 8. To Study Various Logic Gates Such as OR, AND, NOT, NAND, NOR. 9. Study of CRO and Measurement of Voltage and Frequency Using CRO. 10. V-I Characteristics of Zener Diode. 11. Identification of Active and Passive Components. 12. V-I Characteristics of Bipolar Junction Transistor in Common Base Mode.	24

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes*: At the end of the course students will be able*

1. Implement the basic electric circuits using rheostats, bread-board, resistors, capacitors, inductors, diodes, transistors, voltage sources, ICs, transformer, DSO/CRO and measuring devices.
2. Measure the various electrical quantities like voltage, current, frequency, power and energy.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1,PO2 ,PO3,PO4/PSO2, PSO3
CO2	PO1,PO2 ,PO3,PO4/PSO2

BEEC 1016: SIGNALS & SYSTEMS

Credits:4 **L-T-P-J:3-1-0-0**

Module No.	Content	Teaching Hour
I	**Introduction to signals and systems**: Classification of Signals, Transformations of Independent Variables(Time), Singularity Functions: Unit Step, Unit Ramp and Unit Impulse Function, Even and Odd Signals, Periodic and Aperiodic Signals, Real Exponential Signals, Complex Exponential Signals, Energy and Power Signals, **Basic systems**: Causal and Non Causal, Linear & Nonlinear, Time Varying and Time Invariant, System with & without Memory, Convolution Integral **Fourier and Laplace Transform Analysis**: Review of Fourier & Laplace Transforms, Transform of Basic Signals and Periodic and Complex Waveforms, Initial and Final Value Theorems, Inverse Laplace Transform , Application of Fourier and Laplace Transform To Analysis of Networks,	**21**
II	**Z-Transform Analysis**: Concept of Z-Transform, ROC, Properties of Z-Transform, Inverse Z Transform, Initial and Final Value Theorems, Applications to Solution of Difference Equations. **Numerical computation of Discrete Fourier transform**: DFT & its Properties Obtaining output for discrete time systems for any arbitrary discrete input signal Discrete time systems, Discrete time convolution (graphical procedure), DFT method using FFT algorithms: Fast Fourier Transform, DIT FFT & DIF FFT algorithms, DFT & IDFT using FFT algorithms DFT using FFT & Inverse DFT, Discrete-time convolution using FFT	**21**

Text Books:

1. Lathi B P, Principles of Signal Processing & Linear Systems Oxford University Press,

References:

1. A V Oppenheim, A S Willsky, Nawab S N, "Signals & Systems", PHI, Second Edition
2. Nagrath I J, Sharan S N, Ranjan Rakesh & Kumar S, Signals & Systems, Second Edition TMH.

Focus: This course focuses on Employability aligned with all COs.

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

1. Understand the various types of signals, systems, classification and their properties.
2. Compute the Fourier, Laplace Transform, Z-Transform, DTFT, inverse Laplace Transform and inverse Z-Transform of the given signals and/or systems.
3. Apply the FFT algorithms to compute the DFT of given signals.
4. Analyse the stability of system with the help of Laplace, Z transform, and Fourier transform.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PSO1, PSO3
CO2	PO1, PO2, PO3, PO4, PSO1, PSO2
CO3	PO1, PO2, PO3, PO4, PSO2, PSO3
CO4	PO1, PO2, PO3, PO4, PSO1, PSO2

BEEC0007: ANALOG INTEGRATED CIRCUIT

Objective: Ability to define, understands and explain the performance characteristics of Op-amp, applications of Op-amp, working of 555 timer, voltage regulators, A/D and D/A converters.

Credits: 3 **L-T-P-J: 3-0-0-0**

Module No.	Content	Teaching Hour
I	**Review of transistors**: Configurations of BJTs and FETs with their characteristics. **Feedback:** General Feedback Structure; Properties of Negative Feedback Amplifiers and types of feedback amplifier. **Oscillators**: -Conditions for oscillations Basic Principle of Sinusoidal Oscillator, R-C, LC Oscillators. **Current Mirror Circuits:** Current Mirrors using BJT and MOSFETs. Operational Amplifier, Characteristics and Applications: Basic Information of Op-Amp, Operational Amplifier Internal Circuit. DC and AC Characteristics, Instrumentation Amplifier, Applications of Op-Amp. **Active Filters:** First and Second order LP, HP active Filters	21
II	**Active Filters:** First and Second order BP, BS and All pass active Filters **Comparators and Waveform Generators: Comparator**, Regenerative Comparator (Schmitt Trigger), Square Wave Generator (Astable Multi vibrator), Mono stable Multi vibrator, Triangular Wave Generator. Voltage Regulator: Series Op-Amp Regulator, IC Voltage Regulators 555 Timer: Functional Diagram, Mono stable and Astable Operation, Schmitt Trigger. Phase-Locked Loop: Basic Principles, Phase Detector/Comparator, Voltage Controlled Oscillator (VCO), , Monolithic Phase-Locked Loop, PLL Applications A/D and D/A Converters- Weighted Resistors & R-2R D-A Converter, Flash Type, Single Ramp & Dual Ramp A-D Converters.	21

Text Books:

1. A.S. Sedra and K.C. Smith "*Microelectronics Circuits*"4th Edition, Oxford University Press (India).
2. Roy Choudhury, Shail B. Jain "*Linear Integrated Circuits*", 4th Edition, New Age International Publishers

References:

1. R.A. Gayakwad, "*OP-AMP and Linear Integrated Circuits*" Third edition, Prentice Hall of India.
2. Robert L. Boylestad and Louis nashel sky, "*Electronic devices and circuit theory*", Pearson Education/PHI,

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes: *After completing the course the student will able -*

1. Explain the operation of BJT, FET, current mirror circuit, Op-amp, voltage Regulators, 555 timer, PLL.
2. Classify the feedback and oscillator circuit, active filters, A/D and D/A converters.
3. Apply the concept of Op-amp for active filters, different waveform generators, and PLL.
4. Evaluate the analog and digital output from A/D and D/A circuit respectively, and cut cut-off frequency of different types of active filters.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PSO1, PSO2
CO2	PO1, PO2, PO3, PO4,PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4, , PSO1, PSO2, PSO3
CO6	PO1, PO2, PO3, PO4, PSO1, PSO2, PSO3

BEEC0805: ANALOG & DIGITAL ELECTRONICS LAB

Credits: 01 **L-T-P-J: 0-0-2-0**

Objective: *The laboratory serves the students to impart their essential knowledge of analog and digital electronics, to the circuit design and analysis. This laboratory enhances hands on experience of the students to design different electronic circuits with bread-boards and with different active & passive components.*

Module No.	List of Experiments:	Lab Hours
I,II & III	1. To Study V-I Characteristic of JFET and MOSFET. 2. Realization of Multistage Amplifier Using BJT and Calculation of Current Gain. 3. Realization of comparator and zero crossing detector using op- Amp. 4. Realization of adder and subtractor using op-Amp. 5. Realization of 2nd order active low pass and high pass filter. 6. Realization of triangular and sine wave generator using op-Amp. 7. Realization of Astable and Mono stable multi vibrator using IC 555. 8. Realization of full-adder & full subtractor using logic gates and using Boolean expression. 9. Realization of 4-bit even / odd parity checkers using Ex-OR gate. 10. Realization of 4-bit binary decoder/ demultiplexer. 11. Realization of 2-bit/ 4-bit multiplexer. 12. Realization of decimal to BCD encoder using IC 74147. 13. Realization and implementation of RS, JK, T and D flip-flop using logic gates. 14. Realization and implementation serial in parallel out and parallel in serial out shift register. 15. Realization and implementation 4-bit binary ripple counter using JK flip-flop. 16. Realization and implementation of 2-bit up/down synchronous counter.	24

- **Have to perform any 10 experiments out of these.**

Focus: This course focuses on Employability aligned with all COs.

Outcomes: A student who successfully fulfills the course requirements will have demonstrated an ability to:

CO1: design the electronic circuits with basic resistors, capacitors, ICs, and semiconductor devices with the given set of specifications.
CO2: test, and troubleshoot the analog & digital circuits.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1,PO2 ,PO3,PO4/PSO1, PSO2
CO2	PO1,PO2 ,PO3,PO4/PSO1, PSO2

BEEC 0806: ELECTRICAL MACHINES LAB-I

Credits: 1 **L-T-P-J:0-0-2-0**

Objective: To expose the students to the practical concepts of transformer as well as DC machines in order to analyze its performance.

Module No.	Content	Teaching Hours
I	1. To obtain magnetization characteristics of a D.C. shunt generator. 2. To obtain load characteristics of a compound generator (a) cumulatively compounded (b) differentially compounded. To obtain load characteristics of a D.C. shunt generator 3. To obtain efficiency of a dc shunt machine using Swinburn's test. 4. To perform Hopkinson's test and determine losses and efficiency of DC machine. 5. To obtain speed-torque characteristics of a dc shunt motor. 6. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control 7. To study Ward Leonard method of speed control of dc motor. 8. To perform polarity and ratio test of single phase transformer. 9. To perform open circuit and short circuit test in single phase transformer and find efficiency and voltage regulation. 10. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test. 11. To perform polarity and ratio test on 3-phase transformer. To study various connections of 3-pahse transformers. 12. To study Scott connection of transformers.	24

Focus: This course focuses on Employability aligned with all COs.

Outcome: *After successful completion of the lab student will able to*

CO1: Perform the experiment to analyze the characteristics of DC machines and Transformers.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1,PO4/PSO1, PSO2

BEEC0005: FIELD THEORY & APPLICATIONS

Credits: 3 **L-T-P-J: 3-0-0-0**

Module	Contents	Teaching Hours
I	Coordinate Systems and Transformation: Basics of Vectors: Addition, subtraction and multiplications; Cartesian, Cylindrical, Spherical transformation. Vector calculus: Differential length, area and volume, line surface and volume integrals, Del operator, Gradient, Divergence of a vector, Divergence theorem, Curl of a vector, Stokes's theorem, Laplacian of a scalar . Electrostatic fields: Coulombs law and field intensity, Electric field due to charge distribution, Electric flux density, Gausses' Law - Maxwell's equation, Electric dipole and flux line, Energy density in electrostatic fields, Electric field in material space: Properties of materials, convection and conduction currents, conductors, polarization in dielectrics, Dielectric –constants. Electrostatic fields: Continuity equation and relaxation time, boundary conditions, Electrostatic boundary value problems: Poisson's and Laplace's equations., Methods of Images.	21
II	Magneto statics : Magneto -static fields, Biot - Savart's Law, Ampere's circuit law, Maxwell's equation, Application of ampere's law, Magnetic flux density - Maxwell's equation, Maxwell's equation for static fields, magnetic scalar and vector potential. Magnetic forces: Materials and devices, Forces due to magnetic field, Magnetic torque and moment, a magnetic dipole. Magnetization in materials, Magnetic boundary conditions, Inductors and inductances, Magnetic energy. Waves and Applications: Maxwell's equation, Faraday's Law, transformer and motional electromotive forces, Displacement current, Maxwell's equation in final form Electromagnetic wave propagation: Wave propagation in loss dielectrics, Plane waves in lossless dielectrics Plane wave in free space. Plain waves in good conductors, Power and the pointing vector, Reflection of a plain wave in a normal incidence. Transmission Lines and Smith Chart.	21

Text Book:

1. M. N. O. Sadiku , "Elements of Electromagnetic", 4th Edition , Oxford University Press

Reference Books:

1. W. H. Hayt and J. A. Buck, "Electromagnetic field theory", 7th Edision., TMH. Pramanik - Electromagnetism: Vol.1 - Theory, PHI Learning Pvt. Ltd

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes: *After completion of course student will be able to-*

1. *Define various co-ordinate systems, fundamental laws and physical quantities in electromagnetic fields.*
2. *Evaluate the physical quantities of electromagnetic fields (Field intensity, Flux density etc.) in different medium, force exerted on charged particles and current elements.*
3. *Apply different techniques of vector calculus to understand concepts of electromagnetic field theory.*
4. *Analyze EM wave propagation, plane waves in loss and lossless dielectrics, reflection of in normal incidence, power & pointing vector of EM wave.*

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2/ PSO1
CO2	PO1, PO2/PSO1
CO3	PO1, PO2/ PSO1, PSO2
CO4	PO1, PO2, PO3/ PSO1, PSO3

BEEC0009: ELECTRICAL MACHINES-I

Objective: *To expose the students to the key concepts of transformer as well as DC machines and analyze it's performance.*

Credits:3 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**Single Phase Transformers**: Review: Classification; principle of operation, e.m.f. equation, equivalent circuit, losses and efficiency: maximum and all-day; voltage regulation. Testing : open circuit and short circuit tests, load test, Sumpner's test. **Autotransformers**: Principle of operation, equivalent circuit, comparison with two winding transformers **Three phase Transformers**: Construction of three phase transformers and their phase groupings; Phase transformation: three-phase to two-phase. Parallel operation of single and three phase transformers. Harmonics in transformers.	22
II	**D. C. Generators**: Construction, lap and wave type windings, function of commutator, emf equation, types of d.c. machines, characteristics. **D.C. Motors**: Armature reaction and its effects. Commutation: method of improving commutation, interpoles. Torque developed, losses and efficiency, Characteristics of different types of d.c. motors, d.c. motor starters. Testing of dc machines.	20

Text Books:

1. J. Nagrath and D.P. Kothari, "*Electric Machines*" Tata McGraw Hill Education, 2004.
2. J. B. Gupta," Theory and Performance of Electrical Machines", S.K. Kataria and Sons, 2013.
3. Ashfaq Hussain, "*Electric Machines*", Dhanpat Rai and Sons, 2016.

Reference Books:

1. M.G. Say, "*The Performance and Design of AC machines*", Pit man & Sons ,2002.
2. A. E. Fitzgerald, C. Kingsley and Umans, "*Electric Machinery*" 6th Edition, Tata McGraw Hill, 2015.
3. Alexander S. Langsdorf, "Theory of Alternating Current Machinery", McGraw Hill Book Company, 2009.
4. F. Puchstein, T.C. Lloyd, A.G. Conard, "*Alternating Current Machines*", Asia Publishing House, 1962.
5. Alexander S. Langsdorf, " Principles of Direct-current Machines", McGraw Hill Book Company,1940.
6. Albert E.Clayton,"The Performance and Design of Direct Current Machines", The English Language Book Society,2000.

Focus: This course focuses on Employability aligned with all COs.

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

- CO1: Understand the construction and principle of operation of single, three phase transformers and auto transformers.
- CO2: Demonstrate construction and operation of DC generators and DC motors.
- CO3: Evaluate the performance in terms of efficiency, voltage regulation of transformers, and the methods of testing of transformers like open and short circuit tests and the Sumpner's test.

- CO4: Analyze the performance of DC machines by various testing methods including Ward leonard, Swinburn's and Hopkinson.

Mapping of Course Outcomes (CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PSO1, PSO2
CO2	PO1, PO2, PO3, PO4, PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4, PSO2, PSO3
CO4	PO1, PO2, PO3, PO4, PSO2, PSO3
CO5	PO1, PO2, PO3, PO4, PSO1
CO6	PO1, PO2, PO3, PO4, PSO1, PSO2

BEEC0010: ELECTRICAL MACHINES-II

Objective: To expose the students to the key concepts of synchronous as well as induction machines and analyze it's performance.

Credits:3 **L-T-P-J:3-0-0-0**

Module	Content	Teaching Hour
I	**Synchronous Machine-I:** constructional features, emf equation, winding coefficients, rotating magnetic field, armature reaction and Two Reaction Theory, phasor diagram based on Two Reaction Theory, expression for power developed in terms of load angle, open and short circuit tests, voltage regulation by Synchronous Impedance Method, MMF Method, ASA Method, Operation on infinite bus bar, parallel operation of synchronous generators, active and reactive power control of alternators operating on infinite bus bar. **Synchronous Machine-II:** starting of synchronous motors, effect of variation of field current at constant load and V-Curves, synchronous condenser, synchronizing power and torque, hunting.	21
II	**Three phase Induction Machine-I:** constructional features, principle of operation, phasor diagram, equivalent circuit, power flow and efficiency, relation between rotor power input, mechanical power developed and rotor copper loss, expression for torque and torque-slip characteristics. **Three Phase Induction Machine-II:** determination of parameters of equivalent circuit by no load and blocked rotor tests, methods of starting of three phase induction motors. Deep bar and double cage rotors, harmonics and its effects: cogging and crawling, induction generator and its applications. **Single Phase Induction Motor:** Double Revolving Field Theory, equivalent circuit, no load and blocked rotor tests. Different types of single phase induction motors: starting methods, characteristics and applications.	21

Text Books:

1. J. Nagrath and D.P. Kothari, "*Electric Machines*" Tata McGraw Hill Education, 2004.
2. J.B.Gupta," Theory and Performance of Electrical Machines", S.K. Kataria and Sons, 2013.
3. Ashfaq Hussain, "*Electric Machines*", Dhanpatrai and Sons, 2016.

Reference Books:

1. M.G. Say, *"The Performance and Design of AC machines",* Pit man & Sons, 2002.
2. A.E. Fitzgerald, C. Kingsley and Umans, "*Electric Machinery*" 6th Edition, Tata McGraw Hill Education, 2015.
3. Alexander S. Langsdorf, "Theory of Alternating Current Machinery", McGraw Hill Book Company,2009.
4. F. Puchstein, T.C. Lloyd, A.G. Conard, "*Alternating Current Machines*", Asia Publishing House, 1962.

Focus: This course focuses on Employability aligned with all COs.

Course Outcome*: After completion of course student will be able to*

CO1: Explain constructional details of different type of Synchronous and Induction Machines, working principle and speed control concept of Induction Motors.
CO2: Demonstrate the parallel operation of alternators with supply mains.
CO3: Calculate the performance parameters of single phase and three phase induction motors.
CO4: Analyze the performance of synchronous machines by V Curves.
CO5: Evaluate the effects of harmonics on three phase induction motors.

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes (PSO):

Cos	Pos/ PSOs
CO1	PO1, PO2, PSO1
CO2	PO1, PO2, PSO2
CO3	PO2, PO4, PSO3
CO4	PO1, PO2, PO3, PSO3
CO5	PO2, PO3, PO4, PSO3

BEEC0807: ELECTRICAL MACHINES LAB-II

Objective: To expose the students to the practical concepts of synchronous as well as induction machines in order to analyze its performance.

Credits: 1 **L-T-P-J:0-0-2-0**

Module No.	Content	Teaching Hours
I	**Hardware based experiments** 1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit. 2. To perform load test on a three phase induction motor and draw: Torque -speed characteristics 3. To study speed control and reversal of direction of rotation of three phase induction motor by varying supply voltage. 4. To perform open circuit and short circuit tests on a three phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by (i) EMF method (ii) Z P F method 5. To determine V-curves and inverted V-curves of a three phase synchronous motor at no load 6. To determine Xd and Xq of a three phase salient pole synchronous machine using the slip test and draw the power-angle curve. 7. To study synchronization of an alternator with the infinite bus by using two bright and one dark lamp method. **Software based experiments** 8. To determine speed-torque characteristics of three phase slip ring induction motor and study the effect of including resistance in the rotor circuit. 9. To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation. 10. To determine speed-torque characteristics of a three phase induction by (i) keeping v/f ratio constant (ii) increasing frequency at the rated voltage.	24

Focus: This course focuses on Employability aligned with all COs.

Outcomes: *After performing experiments in this lab, students will able to*

- CO1: Perform and analyze the various characteristics of various AC machines.
- CO2: Simulate the speed torque characteristics of induction machines in Mat lab.

Mapping of Course Outcomes (CO) with Program Outcomes (PO) and Program Specific Outcomes (PSO):

COs	POs/ PSOs
CO1	PO1,PO2 /PSO1,PSO2
CO2	PO1, PO2, PO5, / PSO1, PSO2, PSO3

BEEC 0008: DIGITAL ELECTRONICS & CIRCUITS

Objective: To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.

Credits: 3 **L-T-P-J: 3-0-0-0**

Module No.	Content	Teaching Hours
I	**Number Systems &Codes**: Decimal, binary, octal, hexadecimal number system and conversion, Floating point representation, 1's &2's complement, Signed binary numbers, signed binary numbers, weighted binary codes, Excess 3 code, Error Detecting and Correcting Codes. **Boolean Algebra & Minimization**: Boolean logic operation, Boolean laws, Digital Logic Gates, Demorgan's Theorems, Gate-level minimization: K-Map, POS simplification. **Combinational Logic**: Combinational circuits, analysis procedure, design procedure, Binary Adder-Sub tractor, Multiplexers, De-multiplexer, Decoders, Encoders.	20
II	**Synchronous sequential logic:** Sequential Circuits, Storage Elements: Latches, Flip Flops (S-R, J-K, D, T, MASTER SLAVE), Analysis of Clocked Sequential Circuits. **Registers and Counters:** Shift Registers, Ring Counter, Ripple Counter, Synchronous Counter, Other Counters. **Digital integrated circuits:** Logic levels, propagation delay time, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics TTL, CMOS and ECL integrated circuits and their performance comparison, open collector and tri-state gates and buffers. **Memory and programmable logic:** RAM , ROM, PROM, and EPROM.	20

Text Book:

1. M. Morris Mano and M. D. Ciletti, "*Digital Design*" 6th Edition, Pearson Education.
2. S. Salivahanan& S. Asivazhagan, "*Digital Circuit & Design*", IInd Edition

Reference Books:

1. John F.Wakerly, Digital Design, Fourth Edition, Pearson/PHI, 2006
2. John. M Yarbrough, Digital Logic Applications and Design, Thomson Learning, 2002.
3. Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 2003.
4. Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, 6thEdition, TMH, 2003.
5. William H. Gothmann, Digital Electronics, 2nd Edition, PHI, 1982.

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

1. Understand the basics of number system and different logic families.
2. Implement general problems on combinational circuits using optimized logic gates.
3. Construct sequential circuits which includes latches, fli- flop, shift register,ripple counter, synchronous counter, ring counter and also analysis of clocked sequential circuits.
4. Analyse the performance of memory devices like RAM, ROM, PROM, EPROM.

Mapping of Course Outcomes (CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

Cos	POs/ PSOs
CO1	PO1, PO2 /PSO1
CO2	PO1, PO2 / PSO1, PSO2
CO3	PO1, PO2 /PSO1, PSO3
CO4	PO1, PO2, PO3 / PSO1, PSO3

BEEC0004: ELECTRICAL MEASUREMENT & MEASURING INSTRUMENTS

Objective: To understand the internal structure of all instruments that are used in measuring parameters and also difference between analogue meters and digital meters and their performance characteristics.

Credits: 3 **L-T-P-J:3-0-0-0**

Module	Content	Teaching Hour
I	Philosophy of Measurement : Methods of Measurement, Classification & Characteristics of Instrument & Measurement System, Errors in Measurement & Its Analysis, Standards. Measurement of Current and voltage: Classification of Analog instruments. Principle of operation, construction, sources of error and compensations in PMMC, Dynamometer type instruments. Extension of ranges and calibration of ammeters & voltmeters. Measurement of power Power measurement – Voltmeter ammeter method, Electrodynamics wattmeter – Theory, errors and compensation. Instrument Transformers: Instrument Transformers and Applications in the Extension of Instrument Range. Measurement of Circuit Parameters: Different Methods of Measuring Low, Medium and High Resistances, Measurement of Inductance,	21
II	Measurement of Capacitance & Frequency with The Help of AC Bridges. Potentiometer. Sensors and Transducers: Classification of Sensors &Transducers, Resistive Transducers, Inductive Transducers. Digital Measurement: Concept of Digital Measurement, Block Diagram Study of Digital Voltmeter, Frequency Meter Power Analyzer and Harmonics Analyzer; Digital Multi meter Cathode Ray Oscilloscope: Basic CRO Circuit (Block Diagram), Cathode Ray Tube (CRT) & Its Components, Application of CRO in Measurement, Lissajous Pattern; Digital storage oscilloscope (Block Diagram, theory and applications only)	21

Text Books:

1. G.K. Banerjee, Electrical Measurement & Measuring Instruments, New Age International.
A.K. Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai &Sons India.

References:

1. Forest K. Harris, "Electrical Measurement", Willey Eastern Pvt. Ltd. India.
2. M.B. Stout, "Basic Electrical Measurement" Prentice hall of India, India.
3. Helfrick and Cooper, "Modern Electronic Instrumentation & Measurement Techniques", PHI
4. Learning.
5. Rajendra Prashad, "Electrical Measurement & Measuring Instrument", Khanna Publisher.
6. J.B. Gupta, "Electrical Measurements and Measuring Instruments", S.K. Kataria& Sons.
7. MMS Anand, "Electronic Instruments and Instrumentation Technology", PHI Learning.

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

1. Understand measuring parameters, methods, standards, characteristics and errors in electrical and electronic measuring instruments.
2. Explain the application of CT, PT, resistive, inductive and capacitive transducers oscilloscopes and recorders.
3. Evaluate active power, power factor using wattmeter methods & resistance, inductance and capacitance using ac, dc bridges.
4. Analyse the performance characteristics of measuring instruments such as extension of range, Lissajous pattern etc.

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes(PSO)

Cos	POs/ PSOs
CO1	PO1, PO2 /PSO1
CO2	PO1, PO2 / PSO1
CO3	PO1, PO2 / PSO1, PSO2
CO4	PO1, PO2, PO3 / PSO1, PSO2, PSO3

BEEC0810: POWER ELECTRONICS LAB

Credits: 1 **L-T-P-J:0-0-2-0**

Module No.	Content	Lab Hours
I,II & III	**LIST OF EXPERIMENTS** 1. To study V-I characteristics of SCR and measure latching and holding Currents. 2. To study UJT trigger circuit for half wave and full wave control. 3. To study single-phase half wave controlled rectified with (i)resistive load (ii) inductive load with and without free-wheeling diode. 4. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and Inductive loads. 5. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads. 6. To study single-phase ac voltage regulator with resistive and inductive loads. 7. To study single phase cyclo-converter. 8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor 9. To study operation of IGBT/MOSFET chopper circuit. 10. To study MOSFET/IGBT based single-phase bridge inverter. 11. To obtain illumines control using TRIAC. **SOFTWARE BASED EXPERIMENTS (PSPICE/MATLAB)** 12. To obtain simulation of SCR and GTO thyristor. 13. To obtain simulation of Power Transistor and IGBT. 14. To obtain simulation of single phase fully controlled bridge rectifier and draw load voltage load current waveform for inductive load. 15. To obtain simulation of single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load. 16. To obtain simulation of step down dc chopper with L-C output filterfor inductive load and determine steady-state values of output voltage ripples in output voltage and load current. To perform 8-10 experiment from the above list	*24*

Focus: This course focuses on Employability aligned with all COs.

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

CO1: control the output of SCR based rectifiers and loads .

CO2: develop and troubleshoot MATLAB circuits for rectifiers, inverters and choppers.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1,PO2 ,PO3,PO4/PSO1,
CO2	PO1,PO2 ,PO3,PO4/PSO1, PSO1, PSO2
CO3	PO1,PO2 ,PO3,PO4/PSO3

BEEC 0018: Power System Transmission & Distribution

Objective: *The objective of the subject is to identify major components of power transmission and distribution systems. Describe the principle of operation of transmission and distribution equipment & to know and appreciate the key factors in equipment specification and design.*

Credits:03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**Overhead Transmission Line:** Types of conductors; Stranded conductors, ACSR Conductor, bundle conductors. Parameters of transmission line; Resistance, Inductance, Capacitance & conductance. Method for calculations of Inductance & Capacitance of 1-phase & 3-phase single circuit & double circuit Line, concept of GMR and GMD. Skin and proximity effect. **Performance of Transmission Line:** Characteristics & Performance of Transmission Lines; Short, Medium & Long Lines, Generalized Constants. Voltage Regulation and efficiency. Ferranti Effect. **Mechanical Design of Overhead Transmission Line:** Tension & Sag Calculation, Effect of weather conditions. Vibration & dampers. **Insulators:** Insulator materials & types – pin, disc & strain. Voltage distribution across a string &string efficiency. Methods to improve string efficiency; Capacitance grading & Guard ring.	21
II	**Corona:** Corona - Visual & Disruptive, Critical Disruptive Voltage. Corona Loss. Factors affecting Corona, Methods of reducing Corona, Electrostatic & Electromagnetic interference with Communication lines. **Insulated Cables:** Constructional features, Parameters, Cable laying procedures. High Voltage Cables & Thermal characteristics, Fault Location. **Distribution System:** Primary & Secondary Distribution, Ring Main & Radial System, Design of distribution system. **Representation of Power System:** Single Line Diagram, Per Unit system of calculation. Formation of Y-Bus & Z-Bus. **Load Flow Study:** Load Flow Problem, Power Flow Equations, Load Flow solution using Gauss Seidel& Newton Raphsonmethods, decoupled &fast decoupled method, Reactive Power Compensation.	21

Text Books:

1. D.P. Kothari and I.J. Nagarath, “Power System Engineering”, TMH.
2. W. D. Stevenson, “Element of Power System Analysis”, McGraw Hill.
3. M. V. Deshpande, “Electrical Power System Design” Tata Mc Graw Hill.

Reference Books:

1. B.R. Gupta, “Power System Analysis & Design”, S. Chand & Co.
2. Chakraborthy, Soni,Gupta&Bhatnagar, “Power System Engineering”, DhanpatRai& Co.
3. HaadiSaadat, “Power System Analysis”, McGraw Hill Publication.

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

CO1. Understand the skin effect, proximity effect, overhead line conductors and underground cables in power transmission.

CO2. Compute the electrical parameters of overhead transmission lines using the concept of GMD and GMR and load flow problem and various methods.
CO3. Analyze the performance of overhead transmission line, voltage regulation, efficiency and power transfer capability.
CO4. Design overhead transmission lines considering mechanical parameters, insulator, Corona aspects and distribution systems.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

Cos	POs/ PSOs
CO1	PO1, PO2 /PSO3
CO2	PO1, PO2 / PSO3
CO3	PO1, PO2 / PSO3
CO4	PO1, PO2, PO3 / PSO3

BEEC0012: ELEMENTS OF POWER SYSTEM

Credits: 03 **L-T-P-J: 3-0-0-0**

Course Objective: The objectives of this course are to make the students

1. *understand basic structure of power system*
2. *Understand and calculate transmission line parameters*
3. *Evaluate the electrical and mechanical performance of transmission lines*
4. *Understand insulators, corona effect, cables, distribution systems power system earthing and HVDC and EHVAC transmission systems.*

Module No.	Content	No. of Lectures
I	**Introduction:** Structure of Power Systems, Overview & growth of Power Systems; Indian-Scenario, Interconnections and their advantages **Transmission Lines:** Choice of voltage and frequency, Types of conductors, Bundled conductors. Calculation of Electrical parameters of Overhead Transmission Lines; Resistance, Inductance and Capacitance using the concept of GMR and GMD for 1-Phase, 3- Phase, Single Circuit & Double Circuit Lines, Skin effect, Proximity effect. **Transmission Line Performance-I:** Characteristics and Performance of Transmission Lines; Short and Medium - Generalized Constants, Power flow, and Voltage regulation. **Transmission Line Performance-II:** Characteristics and Performance of Long Transmission Lines, Ferranti Effect, Surge Impedance & Surge Impedance Loading. Indian Electricity Rules. **Mechanical Design of Overhead Transmission Lines:** Tension and Sag Calculations, Effect of weather conditions, Stringing Charts, Vibration & Damper.	22
II	**Insulators:** Insulator Types, String Efficiency & Methods to improve String efficiency; Capacitance grading, Guard ring. **Corona and Interference with Communication Lines:** Corona; Visual and Disruptive, Critical Voltage, Corona Loss, Factors affecting Corona. Methods of reducing Corona, Interference with Communication Lines. **Insulated Cables:** Constructional Features, Parameters. Electric stress in single-core cable, grading of cable. Cable laying procedures, Fault location methods. High Voltage Cables. Thermal Characteristics of cables. **Distribution Systems:** Primary and Secondary Distribution, Ring Main and Radial Systems, Systematic design of Distribution Systems. **Power System Earthing:** Soil Resistivity, Earth Resistance, Tolerable Step and Touch Voltage, Actual Touch and Step Voltages, Design of Earthing Grid. **HVDC Transmission and EHV-AC Transmission:** Introduction to HVDC and EHV-AC transmission systems and their comparison.	21

Text Books:

1. D.P. Kothari and I.J. Nagrath, "*Power System Engineering*",3rd edition Tata McGraw Hill, 2019.
2. B. R. Gupta, "*Power System Analysis and Design*", 7th Edition, S. Chand Publishing, 1998
3. John J. Grainger and W. D. Stevenson, Jr, "*Power System Analysis*", 1st Edition, Tata McGraw-Hill, 2004

References:

1. Ashfaq Husain, "Electrical *Power System"*,5th Edition, CBS Publishers and Distributors, 2014
2. C. L. Wadhwa, "*Electrical Power Systems*", 7th Edition, New Age International Ltd., 2017
3. S. N. Singh, "Electric Power Generation, Transmission& distribution." 2nd Edition, PHI Learning, 2021

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes: After completion of the course, students shall be able to:

CO1. Understand the structure of an interconnected power system including generation, transmission and distribution; their function and growth, skin effect and proximity effect.
CO2. Understand the mechanical design of overhead transmission lines considering insulation and Corona aspects and also the constructional features of single and multi-core cables, grading and thermal rating of cables, electric distribution system, power system earthing, HVDC and EHVAC Transmission.
CO3. Calculate the electrical parameters of overhead 1-phase and 3-phase transmission lines using the concept of geometrical mean distances and geometrical mean radius.
CO4. Analyze short, medium and long transmission line models to obtain their performance – voltage regulation, efficiency and power transfer capability.
CO5. Evaluate sag and tension, string efficiency, electric stress in cables and fault location, minimum voltage point for different distribution systems, soil resistivity, step and touch voltage in substations.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PSO1, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4, PSO1, PSO3
CO3	PO1, PO2, PO3, PO4, PSO2,
CO4	PO1, PO2, PO3, PO4, PSO2, , PSO3
CO5	PO1, PO2, PO3, PO4, PSO1,

BEEC 0013: POWER SYSTEM ANALYSIS

Credits: 3 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**Representation of Power System:** Single Line Diagram, Impedance & Reactance Diagram, Per Unit System of calculation. **Load Flow Study:** Network model. Formation of Y_{BUS} by inspection and by graph theory. Formulation of load flow problem. Gauss-Seidel method of load flow-analysis. Representation of voltage-controlled buses in load-flow analysis. Newton-Raphson method of load-flow analysis. Decoupled and Fast Decoupled Methods, Comparison of Load Flow Methods. **Economic Operation of Power Systems:** Economic dispatch problem in thermal power stations. Consideration of transmission losses in economic dispatch. Development of loss-formula. **Fault Analysis**: Types of Fault. Synchronous machine model for fault analysis. Calculation of Fault Current and voltages for symmetrical short circuit.	21
II	**Fault Analysis**: Symmetrical components of unbalanced phasors, power invariance transformation. Sequence impedance and sequence network of power system elements. Unsymmetrical short-circuits. Open conductor fault. Z_{BUS} method for the analysis of unsymmetrical shunt faults. Current limiting reactors. **Transient Stability Studies**: Types of Stability, Swing Equation, coherent group of machines. Power Angle Curve. Equal Area Criterion & Its Applications; Step-by-Step Solution of Swing Equation. Factors affecting stability of system & methods of improving stability **Surge Phenomenon**: Classification of Over-voltages; Travelling Wave Equation for a Long Line, Surge Impedance. Reflection and refraction of surges, Bewly Lattice diagram. Protection from Surges.	20

Text Books:

- I.J. Nagrath and D.P. Kothari, "*Modern Power System Analysis*", Tata McGraw Hill, 4th edition.
- J. Grainger & W. D. Stevenson, "*Power System Analysis*", McGraw Hill.
- B. R. Gupta, "Power System Analysis and Design", S. Chand & Co.

References:

- C. L. Wadhwa, "Electrical Power Systems", New Age International Ltd.
- AshfaqHussain, "Power System", CBS Publishers and Distributors.
- Chakraborthy, Soni,Gupta&Bhatnagar, "Power System Engineering", DhanpatRai& Co.

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completing the course, the students shall be able to:

1. Understand the methods of Y bus, Z bus formulation and G-S, N-R and fast decoupled methods of load flow analysis, over-voltage classification methods of improving stability in power system.
2. Calculate per unit system values, sequence components, fault currents, critical clearing angle, reflection and refraction coefficient for voltage and current wave in transmission line.
3. Evaluate the condition of economic scheduling of thermal power plants including transmission losses.
4. **A**nalyze symmetrical, unsymmetrical faults, economic scheduling and load dispatch, transient stability and traveling wave phenomenon's in power systems.

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes (PSO)

COs	POs/ PSOs
CO1	PO1,PO2 ,PO3,PO4/PSO1,
CO2	PO1,PO2 ,PO3,PO4/PSO1, PSO2
CO3	PO1,PO2 ,PO3,PO4/PSO2
CO4	PO1,PO2 ,PO3,PO4/PSO1, PSO3

BEEC0015: MICROPROCESSOR & IT's APPLICATIONS

Objective: *The Purpose of the course is to provide students with the Knowledge of Microprocessors, basic of Microcontroller and peripheral. To solve real world problems in an efficient manner, this course also emphasis on architecture, Programming and system design used in various day-to-day gadgets.*

Credits: 3 **L-T-P-J: 3-0-0-0**

Module No.	Content	Teaching Hours
I	Introduction to Microprocessor, Components of a Microprocessor: Registers, ALU and control & timing, System bus (data address and control bus), Microprocessor systems with bus organization. Microprocessor Architecture and Operations, Memory, I/O devices, Memory and I/O operations. 8085 Microprocessor Architecture, Address, Data And Control Buses, 8085 Pin Functions, Demultiplexing of Buses, Generation Of Control Signals, Instruction Cycle, Machine Cycles, T-States, Assembly Language Programming Basics, Classification of Instructions, Addressing Modes, 8085 Instruction Set, Instruction and Data Formats, Writing, Assembling & Executing a Program, Debugging the Programs. Writing 8085 assembly language programs with decision, making and looping using data transfer, arithmetic, logical and branch instructions.	21
II	Stack & Subroutines, Developing Counters and Time Delay Routines, Code Conversion, BCD Arithmetic and 16-Bit Data operations, Interrupts In 8085, Interfacing Concepts, Memory Interfacing ,Ports, Interfacing Of I/O Devices, , Programmable Peripheral Interface 8255A, TIMER IC 8253,Programmable Interrupt Controller 8259A, **Advanced Microprocessors**: 8086 logical block diagram and segments, Addressing Modes, **Introduction to Microcontrollers and Embedded Processors**	21

Text Book:

1. B Ram "Fundamental of Microprocessor & Microcontrollers", DhanpatRai publication.

Reference Books:

1. Ramesh S. Gaonkar , "Microprocessor Architecture, Programming, and Applications" with the 8085, Pub: Penram International.
2. N. Senthil Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah "Microprocessors and Interfacing", Oxford
3. Daniel Tabak "Advanced Microprocessors", McGrawHill.
4. Douglas Hall "Microprocessor & Interfacing" , TMH.
5. Savaliya M. T. "8086 Programming and Advance Processor Architecture", WileyIndia.
6. Triebel& Singh "The 8088 and 8086 Microprocessors", Pearson Education.
7. Kenneth Ayala "The 8051 Micro controller" 3rd Edition.

Focus: This course focuses on Employability aligned with all COs.

Outcomes: *After learning, the course the students should be able to:*

1. *Understand the various features of microprocessor,* microcontrollers and embedded system ,*memory and I/O devices including concepts of system bus and 8085 processor addressing modes, instruction classification, function of each instruction, and write the Assembly language programs using 8085 instructions.*
2. *Explain the architecture of 8085 and 8086 microprocessor, its bus organization including control signals.*
3. *Analyze the concepts of memory and I/O interfacing with 8085 processor with Programmable devices.*

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO2 /PSO1
CO2	PO1, PO2/PSO1
CO3	PO1,PO2/PSO1, PSO2

BEEE 0030: ELECTRICAL POWER GENERATION

Credits: 03 **L-T-P-J: 3-0-0-0**

Module No.	Content	Teaching Hours
I	**Introduction:** Importance of Electrical Energy, Comparison with other forms of energy. Electrical energy sources. **Power Plant Economics and Tariffs:** Load Curve, Load Duration Curve, Different Factors related to plants and consumers, Cost of electrical energy. Depreciation, Tariffs, Causes and effects of low power factor. Different methods for power factor improvement and advantages of pf improvement. **Power Plant Auxiliaries:** Excitation system, Turbine and Governors, Storage Batteries. EHV Substation – classification & its equipment. **Thermal Power Plant:** Location and site selection, general layout and working of plant. Brief description of Boilers, Economizers, Super heaters, Draft system. Fuel and Ash handling plant. **Gas Turbine Power Plant:** Layout & operational principle of Gas Turbine Plant & its efficiency, Fuels, Open and Closed-cycle plants, Regeneration, Inter-cooling and reheating.	21
II	**Nuclear Power Plant:** Location, Site selection, General layout and operation of plant, Brief description of different types of Reactors, Moderator material, Fissile materials. Control of nuclear reactors, Disposal of nuclear waste, Shielding. **Hydro Electric Plants:** Classifications, Location and site selection, Detailed description of various components, General layout and operation of plants, Brief description of Impulse, Reaction, Kaplan and Francis turbines. Advantages & disadvantages. **Wind Energy:** Basic principles of Wind energy conversion, Wind energy power calculation, Analysis of aerodynamic forces acting on the Blades, Site selection considerations, Types of wind energy Collectors, applications of wind energy. **Solar Energy:** Solar radiation at the Earth's surface, Solar radiation measurement, Solar energy Collectors, Solar Thermal Power Plant, Solar PV Cells. Applications of Solar Energy. **Neutral Earthing:** Introduction, isolated neutral, earth neural systems-solid, resistance & reactance. Arc suppression coil, voltage transformer earthing transformer. Substation Automation: Requirement & Cost Justification.	21

Text Books:

1. B. H. Khan, "*Non-conventional Energy Resources*", 2nd Edition 2009, Tata Mcgraw-Hill Education.
2. B. R. Gupta, "*Generation of Electrical Energy*", 7th Edition 2017, S. Chand Publication 2017.

References:

1. Soni, Gupta & Bhatnagar, "*A Text Book on Power System Engg. 2nd Edition, 2000",* Dhanpat Rai & Co.

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes: At the end of the course the students will be able to:

1. Understand the concept of various economic factors, load curve, load duration curves, excitation system, turbine & governor and stations storages batteries
2. Explain the operating principle and layout of thermal, hydro, nuclear, gas, wind and solar power plants.
3. Analyze the cost of energy generated, type of tariffs, most economic power factor selection, fill factors & power output of solar PV plant.
4. Classify the neutral earthing and explain requirement of substation automation and cost justifications.

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes (PSO)

COs	POs/ PSOs
CO1	PO1, PO2/ PSO1
CO2	PO1, PO2/PSO1
CO3	PO1/PSO1, PSO2, PSO3
CO4	PO1, PO2/PSO1, PO2

BEEE 0031: HIGH VOLTAGE ENGINEERING

Credits: 03 **L–T–P-J: 3–0–0-0**

Module No.	Content	Teaching Hours
I	Level of high voltage, electrical insulation and dielectrics, importance of electric field intensity in the dielectrics. **Break Down In Gases:** Properties of atmospheric air, SF6 and vacuum ionization processes, Townsend's criterion, breakdown in electronegative gases, time lags for breakdown, Streamer theory, Paschen's law, and breakdown in vacuum. **Break Down In Liquid Dielectrics:** Classification & Properties of liquid dielectric, characteristic of liquid dielectric, breakdown in pure liquid and commercial liquid. **Break Down In Solid Dielectrics**: Classification & Properties of solid dielectrics, intrinsic breakdown, electromechanical breakdown, breakdown of solid, dielectric in Practice, breakdown in composite dielectrics.	20
II	**Generation of High Voltages and Currents:** Generation of high direct current voltages, generation of high alternating voltages, generation of impulse voltages, generation of impulse currents, tripping and control of Impulse generator sources of overvoltage. **Measurement of High Voltages and Currents:** Measurement of high direct current voltages, measurement of high alternating and impulse voltages, measurement of high direct, alternating and impulse currents, Cathode Ray Oscillographs for impulse voltage and current measurements. **Non-Destructive Testing:** Measurement of direct current resistively, measurement of dielectric constant and loss factor, partial discharge measurements. **High Voltage Testing:** Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, testing of transformers, testing of surge arresters.	21

Text Books:

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", 5th Edition, 2017, Tata Mc-Graw Hill.

References:

1. E. Kuffel and W. S. Zacngal, "High Voltage Engineering", 2nd Edition, 2000, Pergamon Press.
2. C. L. Wadhwa, "High Voltage Engineering", 2nd Edition, 2007, Wiley Eastern Ltd.

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes*:* At the end of the course the students will be able to:

1. *Understand fundamental concepts of high voltage AC, DC, impulse generation and destructive and non destructive testing procedure of power equipments.*
2. *Apply the different measurement technique to compute high ac/dc voltage and current*
3. *Analyze the reasons behind electric breakdown in liquids, gases, and solids.*
4. *Design the various ac/ dc high voltages and current generation circuits.*

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes (PSO)

COs	POs/ PSOs
CO1	PO1, PO2/PSO1
CO2	PO1, PO2, / PSO1, PSO2
CO3	PO1, PO2/PSO3
CO4	PO1, PO2, PO3/ PSO1, PSO2, PSO3

BEEE 0032: SMART GRID

Objective: *To enable the students to acquire knowledge on smart grid, different options of architectural design and sensors, measurement technology for various aspects of smart grid, renewable energy sources and power quality management, information and communication technology for smart grid.*

Credits: 03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	Introduction to Smart Grid: Evolution of electric grid, concept of smart-grid, definitions, need of smart grid, functions of smart grid, opportunities & barriers of smart grid, difference between conventional & smart grid, concept of resilient &self-healing grid, present development & international policies on smart grid. Smart Grid Technologies: Part 1 Introduction to smart meters, real time pricing, smart appliances, automatic meter reading(AMR), outage management system(OMS), plug in hybrid electric vehicles(PHEV), vehicle to grid, smart sensors, home & building automation, phase shifting transformers. Smart Grid Technologies: Part 2 Smart-substations, substation automation, feeder automation. geographic information system(GIS), intelligent electronic devices(IED) & their application for monitoring & protection, smart storage like Battery, SMES, pumped hydro, compressed air energy storage, wide area measurement system(WAMS), phase measurement unit(PMU).	22
II	Power Quality Management in Smart Grid Power Quality & EMC in Smart Grid, power quality issues of grid connected renewable energy sources, power quality conditioners for smart grid, web based power quality monitoring, power quality audit. Information and Communication Technology for Smart Grid Advanced metering infrastructure (AMI), home area network (HAN), neighborhood area network (NAN), wide area network (WAN). Bluetooth, zig-bee, GPS, Wi-Fi, Wi-Max based communication, wireless mesh network, basics of CLOUD Computing & cyber security for smart grid. Broad-band over power line (BPL). IP based protocols.	20

Text Books:

- Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley, 2010
- Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press, 2009
- S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
- Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press, 2008

Reference Books:

- Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", ArtechHouse Publishers July 2011
- R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality",2nd Edition, McGraw Hill Publication, 2002

- Yang Xiao, "Communication and Networking in Smart Grids", CRC Press, 2012

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

CO1: Understand the fundamental elements and structure of the smart grid.
CO2: Demonstrate the use of HAN, NAN, WAN for designing a smart grid.
CO3: Analyze communication, networking and sensing technologies involved with the smart grid.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO2
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2
CO3	PO1, PO2, PO3, PO4,/PSO2, PSO3

BEEE 0034: POWER SYSTEM OPERATION & CONTROL

Objective: To expose the students to key concepts of operation and control of modern power system.

Credits: 04 **L–T–P: 3–1–0**

Module No.	Content	Teaching Hours
I	**Introduction:** Concept of energy control center (or) load dispatch centre and their functions, time-scale for various control problem. System hardware configuration – SCADA and EMS functions. State estimation. Various operating states of power system -Normal, alert, emergency, in-extremis and restorative states, state transition diagram. Contingency analysis and security assessment. **System load variation:** Load forecasting and simple techniques of forecasting. **Economic operation:** Unit commitment, Hydro-thermal scheduling – short term and long term. Derivation of transmission loss formula. **Automatic generation control (AGC):** Concept of automatic-generation/load-frequency and voltage control.	21
II	AGC of single area system – modeling of speed governing system and turbine modeling, block diagram representation of single area system, steady state analysis, dynamic response, control area concept, P-I control, AGC and economic dispatch control. **AGC of two area system**: Modeling of two area system for AGC including tie line power flow. Block diagram and state-space representation of two-area system. Static and dynamic response. **Automatic voltage control:** Concept of voltage control - Schematic diagram and block diagram representation, modeling of Excitation system. Voltage and reactive power control: Methods of voltage control by tap changing transformer, shunt compensation, series compensation and phase angle compensation. **Flexible AC transmission systems:** Concept and objectives of FACT's controllers, structure and characteristics of FACT's controllers - TCR, FC-TCR, TSC, SVC, STATCOM, TSSC, TCSC, SSSC, TC-PAR, UPFC.	21

Text Books:

1. D.P. Kothari and I.J. Nagrath, "Modern Power System Analysis" Tata McGraw Hill, 4th edition.
2. P.S.R. Murty, "Operation and control in Power Systems" B.S. Publications.
3. A. J. Wood & B.F. Wollenburg, "Power Generation, Operation and Control "John Wiley & Sons.

References:

1. O.I. Elgerd, "Electric Energy System Theory" Tata McGraw Hill Publishing Company Ltd. New Delhi, Second Edition 2003.

Focus: This course focuses on Employability aligned with all COs.

Outcomes: *Upon completion of this course, students will be able to*

CO1: Understand the modeling and control of single area and two area power system including the concept of AGC.
CO2: Calculate various factors including maximum demand, load factor, demand factor, diversity factor etc.
CO3: Apply the concept of AGC, AVC and FACT controllers in power system operation.
CO4: Analyze the performance of economic operation of interconnected thermal-thermal and hydro-thermal power systems.

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes (PSO):

Cos	Pos/ PSOs
CO1	PO1, PO2, PSO1
CO2	PO1, PO2, PSO2
CO3	PO2, PO4, PO5, PSO3
CO4	PO2, PO3,PO4, PSO3

BEEE 0035: SWITCHGEAR AND PROTECTION

Credits: 03 **L-T-P-J: 3-0-0-0**

Module No.	Content	Teaching Hours
I	**Introduction to Protection System:** Philosophy of protection, nature, causes and consequences of faults, requirements of a protective scheme, Basic terminology and components of protection scheme. Fuse, Isolators. **Relays:** Need for protective relaying,Protective Zones, Primary and back up protection, Properties of protective relaying, Relay classification, Principle and operation of electromagnetic and Induction type relay, Relay settings, Types of Relays; Directional, Distance, Differential, Over Current and earth fault relays, Buchholz relay, Harmonic resistant relay, **Static relays -** (amplitude and phase comparator), Numerical relay/IEDs (Intelligent Electronic Devices).	20
II	**Protection Schemes:** Protection of Feeders, Generator, Transformer and Transmission line. Bus Zone and Pilot protection. **Over Voltage Protection**: Spark gaps, Arresters, Surge absorbers. BIL, Insulation coordination, Grounding of Power System. **Circuit Breakers-I**: Theory of arc formation, properties of arc. Theories of arc Interruption, RRRV, Current chopping, Duties of switch-gear, Resistance switching. Construction and operation of Air CBs, Oil CBs, Single and Multi-break construction, Vacuum circuit breaker, SF_6 circuit breaker, D.C. circuit breaker. **Circuit Breakers-II**: Comparative merits and demerits of CBs, Application of CBs, Circuit breaker rating, Recent development in circuit breakers	20

Text Books:

1. Y. G. Paithankar and S R Bhide, "Fundamentals of Power System Protection", 2nd Edition 2004, PHI.
2. B. Ram and D. N. Vishwakarma, "Power System Protection and Switchgear", 2nd Edition 2017, TMH.

References:

1. Bhavesh Bhalja, R.P.Maheshwari & Nilesh Chothani, " Protection & Switchgear", 2nd Edition 2018, Oxford university press
2. S. S. Rao, "Switchgear Protection and Power System", 14th Edition 2019, KhannaPublishers

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes: *At the end of the course the students will be able to:*

1. *Understand the fundamental concept of protection philosophy, protective relays, BIL, insulation coordination and constructional features of SF6, Air, Oil and Vacuum circuit breakers.*
2. *Distinguish the characteristics of under voltage, over current, differential, distance relays and Lightning arrestors etc.*
3. *Evaluate the various PSM and TSM for desired speed, sensitivity and selectivity of protective relaying.*
4. *Analyze the various protective schemes, breaker ratings and RRRV, CC, resistance switching phenomenon of circuit breakers.*

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2/ PSO1
CO2	PO1, PO2,/ PSO1, PSO2
CO3	PO1, PO2/PSO1,
CO4	PO1, PO2/ PSO1, PSO2, PSO3

BEEE 0050: SENSORS AND TRANSDUCERS

Objective: *To make students familiar with the constructions and working principle of different types of sensors and transducers and their uses.*

Credits:03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**Mechanical and Electromechanical sensor**: Definition, principle of sensing & transduction, classification. Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity. Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes. **Inductive sensor**: common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type, short analysis. LVDT: Construction, material, output input relationship, I/O curve, discussion. Proximity sensor. **Capacitive sensors**: Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics. **Piezoelectric element**: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force & stress sensing, ultrasonic sensors	21
II	**Thermal sensors**: Material expansion type: solid, liquid, gas & vapor Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermister material, shape, ranges and accuracy specification. **Thermoemf sensor**: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type. Radiation sensors: types, characteristics and comparison. Pyroelectric type. **Magnetic sensors**: Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics. Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction, response. Geiger counters, Scintillation detectors, Introduction to smart sensors.	21

Text Books:

- Sensor & transducers, D. Patranabis, 2nd edition, PHI, 2003
- Instrument transducers, H.K.P. Neubert, Oxford University press, 1999
- Measurement systems: application & design, E.A.Doebelin, McGraw Hill, 1990

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

CO1: Understand the basic principle of Sensors and Transducers and their classifications
CO2: Explainthe working principle of Electrical, Thermal and Magnetic Sensors
CO3: Analyze the characteristics of different types of Transducers and Sensors
CO4: Distinguish among different types of Transducers and Sensors

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO2
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO3
CO3	PO1, PO2, PO3, PO4,/ PSO1,PSO2
CO4	PO1, PO2, PO3, PO4,/ PSO2, , PSO3

BEEE 0051: OPTIMAL CONTROL SYSTEMS

Objective: *To aware the students about Stochastic Optimal Linear Estimation, Control Stochastic processes and Microprocessor and DSP control Basic computer Architecture.*

Credits: 03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	General Mathematical Procedures: Formulation of the optimal control Problem, Calculus of variations, Minimum principle, Dynamic Programming, Numerical Solution of Two-point Boundary value problem. Optimal Feedback Control: Discrete-Time linear State regulator, Continuous-Time Linear state Regulator results to solve other linear problems, Suboptimal Linear regulators, Minimum-time Control of Linear Time-Invariant System, Stochastic Optimal Linear Estimation and Control, Stochastic processes and linear systems, Optimal Estimation for Linear Discrete time Systems, Stochastic Optimal Linear Regulator.	20
II	Microprocessor and DSP control Basic computer Architecture, Microprocessor Control of Control System, Single Board Controllers with Custom Designed Chips, Digital Signal Processors, Effect of finite World Length and Quantization on Controllability and Closed Loop–Pole Placement, Effects of Quantization, and Time Delays in Microprocessor Based control systems.	20

Text Books:

1. M. Gopal, "Modern Control Engineering", New Age International Publishers, 1996.
2. B.C. Kuo, "Automatic Control Systems", 10th Ed. McGraw Hill, 2017.

Reference Books:

1. Brain D.O. Anderson, John B. Moore, "Optimal control Linear Quadratic Methods", Prentice Hall of India Private Limited, 2000.
2. D. S. Naidu: Optimal Control Systems, CRC Press, 2002.
3. Sinha: Linear Systems: Optimal and Robust Control, CRC Press, 2007.
4. E. Bryson and Y-C Ho: Applied Optimal Control, Taylor and Francis, 1975.
5. P. Sage and C. C. White, III: Optimum Systems Control (2nd Ed.), Prentice Hall, 1977.
6. D. E. Kirk: Optimal Control Theory: An Introduction, Prentice Hall, 1970.
7. J. L. Crassidis and J. L. Junkins: Optimal Estimation of Dynamic Systems, CRC Press, 2004.

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

CO1: Understand the Formulation of the optimal control Problem, Calculus of variations, Minimum principle, Pole Placement, Effects of Quantization, and Time Delays in Microprocessor Based control systems.

CO2: Analyze Microprocessor Control of Control System, Single Board Controllers with Custom Designed Chips, Digital Signal Processors.

CO3: Estimate optimality for Linear Discrete time Systems Stochastic, Optimal Linear Regulator

CO4: Design Discrete-Time linear State regulator, Continuous-Time Linear state Regulator results to solve other linear problems.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO2
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2
CO3	PO1, PO2, PO3, PO4,/PSO2, PSO3
CO4	PO1, PO2, PO3, PO4/ PSO2, PSO3

BEEE 0055: DIGITAL CONTROL SYSTEM

Objective: *The aim of the course is to present control theory that is relevant to the analysis and design of computer-controlled systems, with an emphasis on basic concepts and ideas.*

Credits: 04 **L-T-P-J:4-0-0-0**

Module No.	Content	Teaching Hours
I	Basic control system, advantages of digital control and implementation problems, basic discrete time signals, Modeling of sample-hold circuit, pulse transfer function, solution of difference equation by z- Transform method. **Design of Digital Control Algorithms:** Steady state accuracy, transient response and frequency response specifications, digital compensator design using frequency response plots and root locus plots. **State Space Analysis and Design:** State space representation of digital control system, conversion of state variable models to transfer functions and vice versa, solution of state difference equations, controllability and observability, design of digital control system with state feedback.	22
II	**Stability of Discrete System:** Stability on the z-plane and Jury stability criterion, bilinear transformation, Routh stability criterion on rth plane. Lyapunov's Stability in the sense of Lyapunov, stability theorems for continuous and discrete systems, stability analysis using Lyapunov's method. **Optimal digital control :** Discrete Euler Lagrange equation, max. min. principle, different types of problems and their solutions.	21

Text Books:

- B.C.Kuo, "Digital Control System", Saunders College Publishing, 1991
- M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 2006

Reference Books:

- R.Leigh, "Applied Digital Control", Prentice Hall, International, 1985
- C.H. Houpis and G.B. Lamont, "Digital Control Systems :Theory, hardware, Software", McGraw Hill publications, 1992

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

CO1: Understand the basic sampling theorem to convert a continuous-time system into a discrete-time system (frequency and time domain techniques) and state space model
CO2: Demonstrate the optimal digital control algorithm
CO3: Determine the poles of a second-order system based on the system's transient response of discrete-time systems
CO4: Analyze the stability of a closed-loop of discrete time systems using R-H criterion and Lyapunov's method
CO5: Design the digital controller and compensator using root locus

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO2
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2
CO3	PO1, PO2, PO3, PO4,/PSO2, PSO3
CO4	PO1, PO2, PO3, PO4/ PSO2, PSO3
CO5	PO1, PO2, PO3, PO4 /PSO1, PSO2, PSO3

BEEE 0056: PLC & SCADA

Credits: 3 **L-T-P-J: 3-0-0-0**

Module No.	Content	Teaching Hours
I	**PLC Introduction:** Technical Definition, advantages, characteristics, Chronological Evolution, Types of PLC: Unitary, Modular, Small, Medium and Large. Block Diagram of PLC: Input/output (I/O) section, Processor Section, Power supply, Memory central Processing Unit: Processor Software / Executive Software, Multi-tasking, Languages, Ladder Language. **Bit Logic Instructions:** I/O Symbols, Numbering system of inputs and outputs, Program format, introduction to logic: Equivalent Ladder diagram of various logic gates, De Morgan theorem validation. **Timers and Counters:** Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Count down (CTD). **Advanced instructions:** Introduction: Comparison instructions, discussions on comparison instructions, "EQUAL" or "EQU" instruction, "NOT EQUAL" or "NEQ" instruction, "LESS THAN" or "LESS" instruction, "LESS THANOR EQUAL' or "LEQ" instruction, GREATER THAN" OR "GRT" instruction, "GREATER THAN OR EQUAL TO" or "GRO" instruction, "MASKED COMPARISON FOR EQUAL" or "MEQ" instruction, "LIMIT TEST" or "LIM" instruction.	23
II	**PLC input output (I/O) modules and power supply:** Classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, parallel I/O systems serial I/O systems. Sinking and sourcing. Discrete input module. Rectifier with filter, threshold detection, Isolation, logic section, specifications of discrete input module, types of analog input module, special input modules, analog output module, **SCADA: D**efinition and history of Supervisory Control and Data Acquisition, typical Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture(First generation-Monolithic, Second Generation-Distributed, Third generation Networked Architecture), SCADA systems in operation and control of interconnected power system,	19

Text Book:

1. "PLC and Industrial application", Madhu chhanda Mitra and Samarjit Sengupta, Pernram international pub. (Indian) Pvt. Ltd., 2011.
2. Ronald L Krutz, "Securing SCADA System", Wiley Publication

Reference Books:

1. Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 3rd Edition.
2. John W Webb, Ronald A Reis, "Programmable Logic Controllers: Principles and Application", PHI Learning, New Delhi, 5th Edition.
3. Stuart A Boyer, "SCADA Supervisory Control and Data Acquisition", ISA, 4th Revised edition

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes: After completion of the course, student shall be able to:

CO 1: Understand numbering system, structure of a PLC, SCADA system, Input/output modules interfacing, components such as power supply, memory etc.

CO 2: Design ladder programs for the problems related to timers and counters and develop the ladder diagrams for various Boolean expressions.
CO 3: Analyze the comparative analysis of instructions including equality and non-equalities.

Mapping of Course Outcomes (CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4, PSO2, PSO3

BEEE0074: COMPUTER AIDED ELECTRIC MACHINE DESIGN

Objective: To expose the students to the key concepts of design of Transformer as well as three-phase induction motors.

Credits: 3 **L-T-P-J:3-0-0-0**

Module	Content	Teaching Hour
I	**Introduction:** Design strategy: Iterative process, selection of design variables, checking of performance parameters. Advantages: Prediction of performance from physical dimensions of machine. **Single and Three-phase Transformer Design:** Output equation, selection of specific loadings. Main dimension of core and shell types of transformer. Transformer windings, concentric, spiral, crossover and disc types of windings; sandwich types coil for shell type transformers. Calculation of operating characteristics: winding, resistance, leakage reactance, voltage regulation, losses and efficiency and no load current, calculation of temperature rise and design of tank and tubes. **Computer Aided Design:** Selection of design variables and performance constraints, Development of flow chart for transformer design incorporating performance constraints.	21
II	**Three-phase Induction Motor Design:** Output equation, selection of specific loadings. **Stator Design**: Calculation of stator turns per phase, selection of shape and number of slots, slot dimensions, length of mean turn. Design of air gap length. **Rotor Design**: Rules for selection of number rotor slots, design of rotor bars and end rings for cage type of rotor. Design of turn per phase for slip ring type rotor. **Calculation of operating characteristics**: Calculation of iron loss and no-load current, Calculation of mmf for air gap, stator core, stator teeth and mmf for rotor core. Calculation for rotor resistance for cage type and slip ring type of motors. Calculation of leakage reactance, total standstill impedance, short circuit current and short circuit power factor. **Computer Aided Design:** Development of flow chart for three-phase InductionMotor design incorporating performance constraints, design conforming to standard frames.	21

Text Books:

1. A. K. Sawhney: Electrical Machine Design, Dhanpat Rai and Sons.
2. S.K. Sen:Principles of Electrical Machine Design with Computer Programs, Oxford and IBH Pub. Company.

Reference Books:

1. M.G. Say: The Performance and Design of Alternating Current Machines,Sir IsaacPitman and Sons and The English Language Book Society.

Focus: This course focuses on Employability aligned with all COs.

Course Outcome*: After completion of course student will be able to*

- CO1: Explain the design details of single, three-phase transformers and three-phase Induction Motor.
- CO2: Develop flow chart for transformer and Induction motor design incorporating performance constraints.
- CO3: Calculate the operating characteristics of transformer and three-phase Induction Motor.
- CO4: Design single, three-phase transformers and three-phase Induction Motor.

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes (PSO):

Cos	Pos/ PSOs
CO1	PO1, PO2, PSO1
CO2	PO1, PO2, PSO2
CO3	PO2, PO4, PSO3
CO4	PO2, PO4, PO5,PSO3

BEEE 0094 : WIND ENERGY CONVERSION SYSTEM

Objective: *To make students familiar with the technology, grid integration and energy assessment for the wind energy conversion system.*

Credits: 03 **L-T-P-J:3-0-0-0**

Module No.	Content	Teaching Hours
I	**BASICS OF WIND ENERGY TECHNOLOGY** Wind statistics- Measurements and data Presentation, Historical developments, latest developments, Indian scenario and worldwide developments, present status and future trends. Wind turbine aerodynamics. **CHARACTERISTICS OF WIND ENERGY** Nature of atmospheric winds- Wind resource characteristics and assessment– Anemometry, speed frequency distribution, effect of height, wind rose, Weibull distribution, atmospheric turbulence, gust wind speed, effect of topography. effect of Reynolds's number, actuator disc, Betz coefficient, design of wind turbine blade, effect of stall and blade tip speed ratio and coefficient of torque. **WIND ENERGY CONVERSION SYSTEM (WECS)** Rotor Selection, Annual Energy Output, HAWT, VAWT, Rotor Design Considerations- Number of Blades, Blade Profile -2/3 Blades and Teetering, Coning- Upwind/Downwind, Power Regulation, Yaw System- Tower, Synchronous and Asynchronous Generators and Loads.	22
II	**VARIABLE SPEED SYSTEMS** Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequencysystems synchronous generator- DFIG- PMSG -Variable speed generators modeling- Variable speedvariable frequency schemes. **GRID CONNECTED SYSTEMS** Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of thepower system including modeling issue.	20

Text Books:

- Steve Parker, "Wind power", Gareth Stevens Publishing, 2004.
- Freris L.L., Wind Energy Conversion Systems, Prentice Hall 1990.
- Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.

Reference Books:

- L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
- S.N.Bhadra, D.Kastha,S.Banerjee,"Wind Electrical Sytems",Oxford University Press,2010.
- Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
- E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge,1976.
- N. Jenkins," Wind Energy Technology" John Wiley & Sons,1997
- S.Heir "Grid Integration of WECS", Wiley 1998.

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

CO1:Understand the existing Wind Energy Conversion System and wind energy potential and application of wind energy with case studies and its environmental impacts.

CO2: Understand the Grid connected system for Wind Energy Conversion System

CO3: Analyze the various aerodynamic loads and its design criterion on wind turbine system and the control mechanism of wind turbine.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO2,PO3 /PSO1, PSO2
CO2	PO1,PO2,PO3 /PSO1, PSO2
CO3	PO1,PO2,PO3 /PSO2, PSO3

BEEE 0870: ELECTRIC DRIVES LAB

Objective: *To develop a basic understanding and control of AC and DC machine using power electronic converters.*

Credits: 01 **L–T–P-J: 0–0–2-0**

Module No.	Content	Lab Hours
I&II	1. To study speed control of separately excited dc motor by varying armature voltage using single-phase fully controlled bridge converter. 2. To study speed control of separately excited dc motor using single-phase dual converter (Static Ward-Leonard Control). 3. To study speed control of separately excited dc motor by varying armature voltage using single phase half controlled bridge converter. 4. To study closed loop control of separately excited dc motor. 5. To study speed control of separately excited dc motor using MOSFET/IGBT chopper. 6. To study speed control of single-phase induction motor using single phase ac voltage controller. 7. To study speed control of three phase induction motor using three phase ac voltage controller. 8. To study speed control of three phase induction motor using three phase current source inverter. 9. To study speed control of three phase induction motor using three phase voltage source inverter. 10. To study speed control of three phase slip ring induction motor using static rotor resistance control using rectifier and chopper. **Simulation Based Experiments (using MATLAB/ Simulink)** 11. To study transient response of separately excited dc motor. 12. To study speed control of separately excited dc motor using single phase full / half controlled bridge converter in discontinuous and continuous current modes. 13. To study speed control of separately excited dc motor using chopper control in motoring and braking modes. 14. To study transient response of three phase induction motor. 15. To study speed control of three phase induction motor using (a) constant/V/F control (b) constant voltage and frequency control.	24

Focus: This course focuses on Employability aligned with all COs.

Outcomes: *On successful completion of the program, the student will be able to:*

1. Articulate power electronics applications in control of speed, torque and other components of motor.
2. Simulate the transient response and speed control of DC and AC Machine.

Mapping of Course Outcomes(CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4,/PSO2, PSO3

BEEE0053: BIOMEDICAL INSTRUMENTATION

Objective: *The course is aimed at giving the students an understanding of the human physiology and the various kinds of measurements involved in it.*

Credits: 04 **L-T-P-J: 3-1-0-0**

Module No.	Content	Teaching Hours
I	**Introduction:** Brief description of cardiovascular, neuronal, respiratory and muscular systems and origin of bio-potential—action potential and resting potential **Bio-electrical signals:** (ECG, EEG, EMG, EOG & ERG) and their characteristics Different types of electrodes for the measurement of ECG, EEG & EMG signals; electrodes tissue interface; contact impedance and its effects. **Cardiovascular system measurements**: measurement of blood flow, volume of blood, cardiac rate, heart sound, hemoglobin, blood glucose **Neuromuscular system measurements:** of neuron potential & muscle potential **Respiratory system measurements:** measurement of CO_2& oxygen concentration in exhaled air.	21
II	**Prosthetics and Therapeutic devices:** artificial heart, artificial kidney, limb prosthetics cardiac pacemakers, defibrillators, ventilators, muscle stimulators, hearing and retinal implants. **Patient monitoring system:** X-ray machine-different types, basic components; intelligent monitoring system—CT scan, MRI, ultrasonography, thermography endoscopy. **Role of laser and microprocessor in health care** **Safety measures:** physiological effects of electricity, shock hazards	21

Text Book:

1. Geddes, L.A and Baker, L. E, Principles of Applied Biomedical Instrumentation, John Wiley & Sons (1989)

References:

1. Cromwell, L, Weibell, F.J and Pfeifer, E. A, Biomedical Instrumentation and Measurements, PHI (2003)
2. Khandpur, R. S, Handbook of Biomedical Instrumentation, 2nd Ed, Tata McGraw Hill (2008)
3. Webster, J. G, Medical Instrumentation-Applications and Design, 3rd Ed. Wiley India(2009)
4. Singh, M, Introduction to Medical Instrumentation, PHI Learning (2010)

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

CO1. Understand the physiology of biomedical system, important body parameters and their implications.
CO2. Understand the working principle of patient monitoring system such as X-ray machine, CT scan, MRI, etc.
CO3. Demonstrate the application of ventilators, defibrillators in diagnostics and therapeutic area and modern technology in health care and safety measures.
CO4. Classify various bio-electric signals and the electrodes associated with them.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2/ PSO1
CO2	PO1, PO2, PO5, PO6/ PSO1, PSO3
CO3	PO1, PO3, PO5, PO6/PSO2, PSO3
CO4	PO1,PO2, PO3/PSO1, PSO2, PSO3

BEEE0076: Electric Vehicles

Objective: *The objective of this is to introduces the concepts, principles, analysis and design of electric and hybrid electric vehicles*

Credits: 04 **L-T-P-J: 3-1-0-0**

Module No.	Content	Teaching Hours
I	**Electric and Hybrid Electric Vehicles** Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains **Energy storage:** Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors **Power Electronic Converter:** Battery Charging Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z-converter for battery charging, High-frequency transformer based	21
II	**Electric Propulsion** EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives **Design of Electric and Hybrid Electric Vehicles** Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design	21

Text Books:

1. Ali Emadi, "Advanced Electric Drive Vehicles" Published by CRC Press April 21, 2017

Reference Books:

1. John G. Hayes, G. Abas Goodarzi, "Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles" John Wiley & sons Publishers Ltd 2018
2. Mi.Chris, M. Abul Masrur, "Hybrid Electric Vehicles : Principles and Applications with Practical Perspectives" ,2nd Edition John Wiley & sons Publishers Ltd 2017.

Focus: This course focuses on Employability aligned with all COs.

Outcome: After completion of course, the student will be able to:

CO1. Understand working of Electric Vehicles and its performance parameter
CO2.Model and Analyze the energy storage for EV and HEV application
CO2. Analyze different power converters topologies used for electric vehicle application
CO4. Develop the electric propulsion unit and its control for EV/HEV applications

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PSO1, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4, PSO1, PSO3
CO3	PO1, PO2, PO3, PO4, PSO1, PSO2, PSO3
CO4	PO1, PO2, PO3, PO4, PSO1, PSO2, PSO3

BEEE0090: Introduction to Renewable Energy Technologies

Credits: 03 **L-T-P-J:3-0-0-0**

Module	Content	Teaching hours
I	Introduction to world energy scenario, Renewable energy resources, Radiation, Solar Geometry, radiation models; Solar Thermal, Optical efficiency, thermal efficiency, concentrators, testing procedures. Introduction to thermal systems (flat plate collector), solar architecture, solar still, air heater, panel systems; Photovoltaic	20
II	Introduction to semiconductor physics, doping, P_N junction, Sola r cell and its I_V characteristics, PV systems components, design of a solar PV systems. Biomass, Biomass resources, wood composition, pyrolysis, gasifies, biogas, biodiesel, ethanol; Wind, Introduction, types of wind machines, Cp- λ curve &betz limits, wind recourse analysis; Systems, stand alone, grid connected, hybrid, system design; Hydro systems , Hydro resources, types of hydro turbine, small hydro systems; Other systems, Geothermal, wave energy, ocean energy.	22

TEXTBOOKS

1. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hill, New Delhi, 1996
2. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991

REFERENCES

1. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
2. D. D. Hall and R. P. Grover, Biomass Regenerable Energy, John Wiley, New York, 1987.
3. J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London, 1986.
4. M. A. Green, Solar Cells, Prentice-Hall, Englewood Cliffs, 1982.

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes: After the completion of this course, students shall be able to

CO1: Recognize the need of renewable energy technologies and their role in global energy demand.
CO2: Choose the conventional and non conventional energy sources.
CO3: Compare the resources and working mechanism for renewable energy sources.
CO4: Assess the resources for appropriate site selection for power generation.

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes (PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4,/PSO1, PSO2
CO4	PO1, PO2, PO3, PO4/ PSO2, PSO3

BEEE0100: Illumination Science & Engineering

Objective: *The course is aimed at giving the students an understanding of several kinds of lighting sources & systems and its electrical control.*

Credits:04 **L-T-P-J: 3-1-0-0**

Module No.	Content	Teaching Hours
I	**Importance of Lighting in Human Life:** Optical systems of human eye, Dependence of human activities on light, performance characteristics of human visual system, Radiant energy and visible spectrum, energy conversion to light, External factors of vision-visual acuity, contrast, sensitivity, time illuminance, colour, visual perception, optical radiation hazards, Good and bad effects of lighting & perfect level of illumination. **Lighting Systems:** Daylight, incandescent, electric discharge, fluorescent, arc lamps and lasers; Energy efficient lamps; Artificial lighting as substitute to natural light. **Light sources and their assets:** Laws of illumination, polar, curves, photometry, photocells. Environment and glare.General illumination design, Illumination levels, loss factors, lamp selection and maintenance, types of lamps, lamp fittings, Light control, design aspects of indoor and outdoor lighting	21
II	**Electrical Control of Light Sources:** Ballast, ignitors and dimmers for different types of lamps. Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification & Measurement of Light, Luminaries, wiring, switching and control circuits. Interior lighting Design: Industrial, residential, office departmental stores, indoor stadium, theatre and hospitals. **Exterior lighting Design:** Flood, street, aviation and transport lighting, lighting for displays and signalling - neon signs, LED-LCD displays beacons and lighting for surveillance. Energy Conservation codes for lighting; lighting controls-daylight sensors and occupancy sensors; controller design. Special Features of Aesthetic Lighting	21

Text Book:

1. H. S. Mamak, “Book on Lighting”, Publisher International lighting Academy
2. Joseph B. Murdoch, “Illumination Engineering from Edison’s Lamp to Lasers” Publisher -York, PA: Visions Communications
3. M. A. Cayless, A. M. Marsden, “Lamps and Lighting”, Publisher-Butterworth-Heinemann(ISBN978-0-415-50308-2)
4. Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002
5. John Matthews Introduction to the Design and Analysis of Building Electrical Systems, Springer, 1993

Reference Books:

1. “BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting”, Manak Bhavan, New Delhi
2. D. C. Pritchard, “Lighting”, 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422-0
3. “IES Lighting Handbook”, (Reference Volume 1984), Illuminating Engineering Society ofNorth America.
4. “IES Lighting Handbook”, (Application Volume 1987), Illuminating Engineering Society ofNorth America
5. IESNA lighting Handbook., Illuminating Engineering Society of North America 9th edition2000
6. Applied Illumination Engineering, Jack L. Lindsey FIES (Author), Scott C. Dunning PHD PECEM (Author) ,ISBN-13: 978-0824748098 ISBN-10: 0824748093, 3rd Edition.IS 3646: Part I: 1992, Code of practice for interior illumination.
7. Organic Light Emitting Diodes (OLEDs): Materials, Devices and Applications, Alastair Buckley,University of Sheffieid, UK, ISBN: 978-0-85709-425-4.

Focus: This course focuses on Employability aligned with all COs.

Outcome: *After completion of course, the student will be able to:*

CO1. Understand the concept of illumination, lighting systems, lighting sources and exterior security lighting systems.
CO2. Compare various lighting systems and their inherent properties working in the narrow range of wavelengths from 380 nm to 730 nm.
CO3. Compute various parameters of photometric light sources, laws of illumination, photometry etc.
CO4. Design modern lighting sources and controls for energy efficient lighting and a smart control drive circuit.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3/ PSO1
CO2	PO1, PO2, PO3, PO4, PO6/ PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4, PO6/PSO2
CO4	PO1,PO2,PO3, PO4, PO5, PO6, PO7/ PSO2, PSO3

BEEE0112: DIGITAL SIGNAL PROCESSING

Credits: 04 **L–T–P: 3–1–0**

Module No.	Content	Teaching Hour
I	Review of discrete time signals and systems, Sampling of CT signals: Periodic sampling, Frequency domain representation of sampling, Reconstruction of bandlimited signal from its samples, Discrete time processing of continuous time signals, Continuous discrete time signals, Changing the sampling rate using discrete time processing. Discrete time systems: Linear time invariant discrete time systems, Characterization of LTI systems. Transform domain representation of signals and systems: The discrete time Fourier transform, the frequency response, the transfer function, Discrete Fourier series, Discrete Fourier transform, Computation of DFT	21
II	Linear convolution using DFT, FFT Algorithms, Direct Computation of the DFT Radix-2 FFT algorithms, Gortezel Algorithm, Chirp Z-transform The z-transform, The region of convergence of z-transform Structures for discrete time systems: Block diagram and signal flow representation of constant coefficient, linear difference equation, Basic structures for IIR systems, Basic structures for FIR systems, Lattice structures, Effects of coefficient quantization, Effect of roundoff noise in digital filters, Zero-input limit cycles Filter design techniques: Design of discrete time IIR filters from continuous time filters, Design of FIR filters by windowing, Optimum approximation of FIR filters, Linear phase filters.	21

Text book:

1. Oppenheim & Schafer, "Digital Signal Processing" PH

References:

1. John G Prokias, Dimitris G Manolakis, "Digital Signal Processing", Pearson Education.

Focus: This course focuses on Employability aligned with all COs.

Outcomes: After completion of course, the student will be able to:

1. *Understand the basic discrete-time signals and systems, concepts of continuous time sampling, convolution sum, impulse and frequency response concepts for linear, time-invariant (LTI) systems, difference equation realization of LTI systems and discrete-time Fourier transform and basic properties of these.*
2. *Compute Discrete Time Fourier Transform, Discrete Fourier Series and Discrete Fourier Transform, linear convolution using DFT. FFT algorithms, z- Transform and its region of Convergence, etc.*
3. *Analyze the effects of coefficient quantization, round-off noise in digital filters and limit cycles.*
4. *Build discrete time system structures for IIR and FIR systems such as Direct-I, Direct-II, lattice structures, etc.*
5. *Design discrete time IIR and FIR filters using different approaches.*

Mapping of Course Outcomes (CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2/ PSO1, PSO2
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2
CO3	PO1, PO2, PO3, PO4, PO5/ PSO2, PSO3
CO4	PO1, PO2, PO3, PO4, PO5/ PSO2, PSO3
CO5	PO1, PO2, PO3, PO4, PO5/ PSO2, PSO3

BEEO 0092: NON CONVENTIONAL ENERGY RESOURCES

Open electives offered by EE dept. for ME, CS, EC & CE

Credits: 04 **L–T–P-J: 4–0–0-0**

Module No.	Content	Teaching Hours
I	**Introduction Various non-conventional energy resources-** Introduction, availability, classification, relative merits and demerits. Solar Cells: Theory of solar cells. solar cell materials, solar cell power plant, limitations. **Solar Thermal Energy:** Solar radiation flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations. **Geothermal Energy:** Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations.	20
II	**Magneto-hydrodynamics (MHD):** Principle of working of MHD Power plant, performance and limitations. Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations. Thermo-electrical and thermionic Conversions: Principle of working, performance and limitations. **Wind Energy:** Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics**.** Performance and limitations of energy conversion systems**.** **Bio-mass:** Availability of bio-mass and its conversion theory. **Ocean Thermal Energy Conversion (OTEC)**: Availability, theory and working principle, performance and limitations. **Wave and Tidal Wave**: Principle of working, performance and limitations. Waste Recycling Plants.	20

Text Book:

1. B. H. Khan "Non-Conventional Energy resource" second edition Tata McGraw-Hill Education Private Ltd.

References Books:

1. Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.
2. F.R. the MITTRE, "Wind Machines" by Energy Resources and Environmental Series.
3. Frank Kreith, "Solar Energy Hand Book".

Focus: This course focuses on Employability aligned with COs.

Outcomes: *On successful completion of the program, the students will be able to*

- *CO1: Explain the need of green energy sources across the domains.*
- *CO2: Compare the resources and working mechanism of various renewable energy techniques.*
- *CO3: Acquired skills in the scientific and technological communications, and in the preparation, planning and implementation of energy projects.*
- *CO4: Analysis and design of renewable energy source for a site.*

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes (PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4,/PSO1, PSO2
CO4	PO1, PO2, PO3, PO4/ PSO2, PSO3

BEEE0037: COMPUTER METHODS IN POWER SYSTEMS

Objective: *To introduce computer applications in the analysis of power systems and to understand the solution methods and techniques used in power system studies.*

Prerequisite: Power System Analysis (BEEC0013)

Credits: 04 **Semester VII** **L–T–P: 3–1–0**

Module No.	Content	Teaching Hours
I	**Topological Analysis of Power Networks:** Introduction, Primitive Impedance and Admittance Matrices, System Graph for Transmission Network, Transmission Network Representations, Network Matrices, Network Reduction. **AC Power Flow analysis:** Power Flow Equations, Gauss-Seidel Method, Newton Raphson Load Flow Method, Decoupled and Fast Decoupled Load Flow Method. **Optimum Power Flow:** Classical Method of Economic Load Dispatch with and without Considering Losses, Derivation of Loss-Formula, Optimal Power Flow.	20
II	**Fault Analysis in Large Power System:** Introduction, Formulation of Z_{BUS} Types of Faults, Symmetrical and Asymmetrical Faults, Short Circuit Analysis in a Large PowerSystems using Z_{BUS}, Analysis of Open Circuit faults. **Security Analysis:** Introduction, static security analysis, concept of linear sensitivity factors: Generation outage sensitivity factor (GOSF), Line outage sensitivity factor (LOSF), DC Load Flow, Contingency Analysis, Analysis of multiple contingencies, Contingency ranking and selection. **Stability Analysis:** Classification of power system stability, equation of motion of a synchronous generator, Representation of Generators and loads for transient stability analysis, Transient stability analysis of Multi-Machine Systems.	20

Text Book:

- G.W. Stagg & A.H. El-Abiad,'Computer Methods in Power System Analysis', Mc-Graw Hill, 1988.
- Haadi Saadat, 'Power System Analysis', Mc-Graw Hill, 2010.

References:

- John J. Grainger and William D. Stevenson Jr., 'Power System Analysis', Mc-Graw Hill, 2011.
- M A Pai and Dheeman Chatterjee, 'Computer Techniques in Power System Analysis', Mc-Graw Hill, 2017.
- A.R. Bergen and Vijay Vittal, 'Power Systems Analysis',Pearson Education Asia, 2001.
- J.D. Glover, M. Sharma and T.J. Overbye, 'Power SystemAnalysis and Design', Fourth Edition, ThomsonEngineering Press, 2008.

Focus: This course focuses on Employability aligned with all COs.

Outcome: *On successful completion of the program, the student will be able to:*

1. *Understand the modeling issues and analysis methods for the power flow, short circuit, contingency and stability analysis, required to be carried out for the power systems.*
2. *Determine the operating conditions of a system according to the demand without violating the technical and economic constraints.*
3. *Evaluate the effect of outage of any important component of power system on the operation and reliability of power systems.*
4. *Analyze the solution methods used in power system studies.*

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PSO1
CO2	PO1, PO2, PO3, PSO3
CO3	PO1, PO2, PO3, PSO3
CO4	PO2, PO3, PO4, PSO3

BEEE00852: COMPUTER METHODS IN POWER SYSTEMS LAB

Objective: *To introduce computer applications in the analysis of power systems and to understand the solution methods and techniques used in power system studies.*

Pre/Co-Requisite: Power System Analysis (BEEC0013)/BEEE0037

Credits: 01

L–T–P: 0–0–2

Module No.	Contents	Lab Hours
I,II	MATLAB/ETAP Based Experiments - 1. To formulate Y Bus matrix for a given power system. 2. To formulate Z Bus matrix for a given power system. 3. To perform the load flow analysis using Gauss Seidel Method. 4. To perform the load flow analysis using Newton-Raphson Method. 5. To perform the load flow analysis using Fast Decoupled Method. 6. To perform optimal load dispatch of generators using analytical and graphical method. 7. To obtain the equations describing the motion of the rotor angle and the generator frequency for a given power system. 8. Determine the critical clearing angle and the critical fault clearing time when a 3-phase fault occurs at the sending end of the line. 9. Determine the critical clearing angle and the critical fault clearing time when a 3-phase fault occurs at the middle of the line. 10. To conduct short circuit analysis for a given power system. 11. To carry out security analysis for a given power system.	24

Focus: This course focuses on Employability aligned with all COs.

Outcome: *On successful completion of the program, the student will be able to:*

1. *Implement the algorithms required to find out parameters for monitoring and control of power system in real time from actual measurement data.*
2. *Apply computer algorithms, used to solve algebro-differential pertaining to power system, to assess the stability performance of power systems in MATLAB/ETAP environment.*

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PSO3
CO2	PO2, PO3, PO4, PSO2

BEEE 0072: ELECTRIC DRIVES

Objectives:

- To learn the fundamental concepts of dynamics and control of Electric Drives.
- To study the criterion for selection of drives for various applications.
- To study the traditional methods of speed control.
- To learn the static control of DC and AC Drives.

Credits: 03 **L–T–P-J: 3–0–0-0**

Module	Content	Teaching Hour
I	**Types of Drives and Loads**: Classification of electric drives, comparison with other types of drives. Characteristics of different types of mechanical loads, stability of motor-load systems. **Selection of Motor Power Rating:** Thermal loading of motors, estimation of motor ratings for continuous, intermittent and short time duty loads. Fluctuating loads and load equalization. **Classical Methods of speed control:** Speed control of d.c. motors: rheostatic, field and armature control methods. Speed control of induction motors: stator voltage control, frequency control, pole changing and rotor resistance control methods. **Static Control of D.C. Drives**: Phase control of fully controlled dc drives: continuous and discontinuous conduction modes of operation.	21
II	Chopper controlled drives: TRC and CLC controls, continuous, discontinuous and critical conduction modes of operation. Closed loop control of d.c. drives: phase and chopper controlled drives. Electric braking of d.c. drives. **Static Control of A.C. Drives**: Static stator voltage control, variable frequency Constant volts/Hertz control, slip power recovery schemes. Method of voltage injection in rotor circuit. Introduction to vector control. Closed loop control of induction motor drives: VSI control, static rotor resistance control, Electric braking of induction motor drives.	20

Text Book:

1. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House New Delhi, 2010.
2. S. K. Pillai, "A First Course on Electric Drives", New Age Publication 2012.

Reference Books:

1. Vedam Subrahmanyam, "Electric Drives: Concepts and Applications", Tata McGraw Hill 2010.
2. Bimal K. Bose, "Modern Power Electronics and A.C. Drives", Pearson Education, India 2003.
3. Joseph Vithayathil, " Power Electronics, Principles and Applications", McGraw Hill, Inc 2010.
4. R. Krishnan," Electric Motor & Drives: Modeling, Analysis & Control, PHI Pvt. Ltd. 2001.

Focus: This course focuses on Employability aligned with all COs.

Course Outcomes: After learning the course the students should be able to:

CO1: Understand the basics of Speed–torque characteristics of electrical machines, static devices, and closed-loop control.
CO2: Compute the thermal heating and cooling time constants of electric drives.
CO3: Analyze the static control of DC and AC drives; and electric braking of drives.
CO4: Design the phase-controlled, chopper-controlled, and closed-loop controller of DC and induction motor drives.

Mapping of Course Outcomes (CO) With Program Outcomes (PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, / PSO1
CO2	PO1, PO2/ PSO1, PSO2
CO3	PO1, PO2, PO3, /PSO2, PSO3
CO4	PO1, PO2, PO3/ PSO2, PSO3

BEEJ0966: Electric Vehicles Project

Objective: The objective of the project is to develop the analysis and design of electric and hybrid electric vehicles in any of one domain mentioned in the list.

Credits:02 **L-T-P-J:0-0-0-8**

Module No.	Content	Teaching Hours
I	**Student may choose any project from the mentioned domain:** **1.** Modelling of a Hybrid Electric Vehicle using ADVISOR ADVISOR can be used for the analysis of performance, fuel economy, and emissions of conventional, electric, hybrid electric, and fuel cell vehicles. The backbone of the ADVISOR model is the Simulink block diagram. In the project student will model and simulate the performance of different hybrid energy sources for hybrid vehicle. **2.** Control Strategy of Hybrid Fuel Cell Power System Fuel cell is used as main source in electric vehicle. This project will focus on control strategy of fuel cell for steady state load current at load transient. **3.** Electric Rikshaw Range Modelling The project will focus on modelling & simulation of range for the commercially available E-Riakshaw and compare the results with E-Rikshaw available with GLA University. **4.** Modelling of Transmission System In HEV, the transmission system perform the task which controls the direction and amount of power flow on the vehicle so as the overall efficiency of a hybrid vehicle is improved. The project will focus the modelling of transmission system in MATLAB.	24

Focus: This course focuses on Employability aligned with COs.

Outcome: After completion of course, the student will be able to:

CO1: Model and Analyze the various components used in EV/HEV

CO2: Analyze the performance of vehicle

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PSO1, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4, PSO1, PSO2, PSO3

BEEE0851: INTELLIGENT TECHNIQUESIN ELECTRICAL ENGINEERING LAB

Objective: *To develop a basic understanding of Artificial intelligence techniques, and their applications to Electrical Engineering and to provide motivation to design intelligent systems and control. Computer simulation of intelligent control systems to evaluate the system performance.*

Pre/Co-Requisite:*BEEE0036*

Credits: 01 **L–T–P: 0–0–2**

Module No.	Contents	Lab Hours
I	1. To study MATLAB tools for Neural Networks. 2. To study MATLAB tools for Fuzzy Logic. 3. To study MATLAB tools for Genetic Algorithm. 4. Training algorithms of neural networks and fuzzy logic 5. Implementation of fuzzy logic, Neural networks and genetic algorithms on various applications.	24

Focus: This course focuses on Employability aligned with all COs.

Outcome: *On successful completion of the program, the student will be able to:*

1. *Implement neural networks and fuzzy logic for classification, control system and optimization problems.*
2. *Simulate the fuzzy controllers using intelligent algorithms in MATLAB environment.*
3. *Obtain the optimum solution of well formulated optimization problem using Genetic Algorithm.*

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PSO2
CO2	PO1, PO2, PO3, PSO2
CO3	PO1, PO2, PO3, PO5, PSO3

BEEE0036: INTELLIGENT TECHNIQUESIN ELECTRICAL ENGINEERING

Objective: *To develop a basic understanding of Artificial intelligence techniques, and their applications to Electrical Engineering and to provide motivation to design intelligent systems and control.*

Credits: 03 **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	**Introduction:** Motivation, Rationale for using Artificial Intelligence (Neural Network, Fuzzy, Evolutionary Computation) in Engineering. **Artificial Neural Network:**Concept of Artificial Neural Networks (ANN), Adaline, Linear Separable Patterns, Single Layer Perceptron, Multilayer Perceptron,Neural Network (NN) architecture, NN Classifications, Back Propagation Algorithm, Radial Basis Function Network (RBFNN), Applications of ANN. **Fuzzy Logic**:Introduction, Classical Sets, Classical Sets Operations, Properties of Classical Sets, Fuzzy Sets, Fuzzy Membership Functions, Fuzzy Set Operations, Properties of Fuzzy Sets, Alpha-Cut Fuzzy Sets, Extension Principle.	21
II	**Fuzzy Logic:**Fuzzy Measures, Measures of Fuzziness, Classical Relations vs. Fuzzy Relations, Predicate Logic, Fuzzy Logic, Approximate Reasoning, Fuzzy Rule Based System, Fuzzy Logic Controller, Applications of Fuzzy Logic. **Evolutionary Computation:** Introduction to Evolutionary algorithms, Genetic Algorithm (GA), solution, initial population, genetic operators, fitness function, stopping condition, fitness scaling, rank scaling, proportional scaling, top scaling, selection, Roulette Wheel selection, stochastic universal sampling, rank selection, tournament selection, other selection methods, mutation, uniform mutation, Gaussian mutation, variable mutation rate, crossover techniques, other genetic operators, Generation Gap, Elitism, Duplicates, Genetic Search, Genetic Programming, Applications of GA.	21

Text Book:

- Ali Zilouchian, Mo Jamshidi, “Intelligent control systems using soft computing methodologies”, CRC Press, 2001.
- James M. Keller, Derong Liu, David B. Fogel, “Fundamentals of Computational Intelligence. Neural Networks, Fuzzy Systems, and Evolutionary Computation”, Wiley, 2016.
- Chennakesava R. Alavala, “Fuzzy Logic and Neural Networks-Basic Concepts and Applications” New Age Publications (Academic), 2008.

Reference Book:

- Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley India, 2010.
- AnupamShukla, RituTiwari, Rahul Kala**,** “Real Life Applications of Soft Computing”, CRC Press, T & F Group, 2010.
- Kevin M. Passino and Stephen Yurkovich, “Fuzzy Control”, Addison Wesley Longman, Menlo Park, CA, 1998.
- Kevin Warwick, Arthur Ekwue and Raj Aggarwal, “Artificial Intelligence Techniques in Power Systems”, Institution of Engineering and Technology, London, UK, 1997.

Focus: This course focuses on Employability aligned with all CO3, CO4 and CO5.

Outcome: *On successful completion of the program, the student will be able to:*

1. *Understand the basics of Neural Network, Fuzzy and Evolutionary Computation.*
2. *Apply the neural networks for classification, control system and optimization problems.*
3. *Analyze the performance of optimization problem using Genetic Algorithm.*
4. *Design intelligent controllers for the given problem.*

5. *Formulate intelligent algorithms for typical electrical applications.*

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PSO1
CO2	PO1, PO2, PSO2
CO3	PO2, PO3, PSO3
CO4	PO3, PO4, PSO3
CO5	PSO3, PO3, PO5

BEEE0071: SPECIAL ELECTRIC MACHINES

Objective: *To make the student able to understand the constructional and operational working of the Single phase synchronous motor, stepper motor, two phase AC servomotor, single phase commutator Motors and linear induction motor.*

Credits: 03 **L-T-P-J: 3-0-0-0**

Module No.	Content	Teaching Hours
I	**Single Phase Synchronous Motor:** Construction, principle of operation and characteristics of: reluctance motors, hysteresis motors, switched reluctance motors. **Stepper Motors:** Construction and principle of operation of: variable reluctance, permanent magnet and hybrid stepper motors. **Permanent Magnet Machines:** Permanent magnet ac and dc motors: brushless dc motors and their important features and applications, PCB motors, introduction to permanent magnet generators.	21
II	**Two-Phase AC Servomotors:** Construction, torque-speed characteristic, performance and applications. **Single-Phase Commutator Motors**: Construction, principle of operation and applications of: universal motor, single phase a.c. series motor, repulsion motors. **Principle of voltage injection:** Principle of voltage injection in rotor circuit of slip ring induction motor: Schrage Motor. **Linear motors**: Construction and principle of operation of Linear induction motors.	21

Text Books:

1. J. Nagrath and D.P. Kothari, "*Electric Machines*" Tata McGraw Hill.
2. J.B.Gupta," Theory and Performance of Electrical Machines", S.K. Kataria and Sons.
3. AshfaqHussain, "*Electric Machines*", Dhanpatrai and Sons.

Reference Books:

1. PenshawTaylor, "The Performanceand Design of A.C. Commutator Motors", A.H.Wheeler& Co.
2. Cyril G. Veinott , "Fractional and Sub-fractional horse power electric motors", McGraw Hill.
3. M.G. Say, "*The Performance and Design of AC machines*", Pit man & Sons.
4. A.E. Fitzgerald, C.KingsleyandUmans, "*Electric Machinery*" 6th Edition, Tata McGraw Hill.
5. F.Puchstein, T.C. Lloyd, A.G. Conard, "*Alternating CurrentMachines*", Asia Publishing House.

Focus: This course focuses on Employability aligned with all CO2, CO3 and CO4.

Outcome: After completion of course, the student will be able to:

1. *Understand the working principle of hysteresis motors, PCB motor,* permanent magnet generators *repulsion motor and linear induction motor.*
2. *Analyze the concept of speed control of permanent magnet dc motor, universal motor and Schrage motor.*
3. *Compute the various type of performance parameters of reluctance motor, stepper motors, permanent magnet dc motor, brushless dc motors and two-phase AC servomotor.*
4. *Apply concept of voltage injection method in 3 phase induction motor.*

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4,/PSO2, PSO3
CO4	PO1, PO2, PO3, PO4/ PSO2, PSO3

BEEE 0078: UTILIZATION OF ELECTRIC POWER & TRACTION

Credits: 04 **L-T-P-J: 4-0-0-0**

Module No.	Content	Teaching Hours
I	**Illumination engineering:** Nature of light, general terms used in illumination, sensitivity of the eye, production of light, incandescent lamps, arc lamps, gas discharge lamps-fluorescent lamps, comparison of magnetic and electronic ballast circuit, polar curves. Distribution and control of light, solid angle, inverse square and cosine laws, lighting calculations, methods of calculations, factory lighting, flood lighting and street lighting. **Refrigeration:** Electrical circuits used in domestic refrigerator. **Electrolysis:** Review of electrolytic principles, laws of electrolysis, current efficiency, energy efficiency, electrodeposition, anodizing, electroplating , extraction of metals, refining of metals. **Electric heating:** Electrical heating advantages, methods and applications, resistance heating, design of heating elements, induction heating, core type furnaces, core less furnaces and high frequency eddy current heating, dielectric heating, arc furnaces (direct arc furnaces, Indirect arc furnaces), electrodes, power supply and control.	21
II	**Welding:** Different methods of electrical welding, resistance welding, arc welding, laser welding, electron-beam welding and welding transformers. **Traction system:** Different system of electric traction and their advantages and disadvantages, Special features of traction motors, selection of traction motor, mechanics of train movement, simplified speed time curves for train movement, crest, average and schedule speed, tractive effort, specific energy consumption, adhesive weight and coefficient of adhesion. **Power supply for electric traction:** Conductor rail system, bow collector, pantograph collector, main parts of AC electric locomotive unit, use of boosters to minimize interference with communication lines **Applications:** Tramways, trolley bus, diesel electric traction.	21

Text Books:

1. H.Partab,"Art and Science of Electrical Energy" DhanpatRai& Sons publications.
2. J. B. Gupta, "Electrical Power Utilization" S.K.Kataria& Sons publication.

Reference Books:

1. S. Sivanagaraju, M. Balasubba Reddy & D. Srilatha, "Generation and Utilization of Electrical Energy", Pearson Publications.
2. N.V. Suryanarayana,"Utilization of Electric Power" Wiley Eastern publication.

Focus: This course focuses on Employability aligned with all COs.

Outcome: *After completion of course, student will be able to:*

CO1: *Explain application of electric power in Illumination, refrigeration, electrolysis, heating, welding and traction system.*

CO2: *Compare electrical characteristics of different illumines, heating and welding schemes*

CO3: *Analyze role of speed-time curves, tractive effort, specific energy consumption and power supply for an electric traction system*

CO4: *Design a heating element and lighting scheme for a given application*

CO5: *select a suitable motor for traction application*

Mapping of Course Outcomes (CO) With Program Outcomes(PO) and Program Specific Outcomes(PSO)

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4,/PSO2, PSO3
CO4	PO1, PO2, PO3, PO4/ PSO2, PSO3
CO5	PO1, PO2, PO3, PO4 /PSO1, PSO2, PSO3

BEEG0002/BEEE: ELECTRICAL TECHNOLOGY

Credits: 03 **L–T–P-J: 3–0–0-0**

Module No.	Content	Teaching Hours
I	**Introduction to Power Generation** Power generation scenario in India**,** conventional generation and plant layout: Hydroelectric power generation, thermal power generation, Nuclear power generation, comparison. Renewable generation and system layout: photovoltaic generation, wind power, tidal power, geothermal power, fuel cell. Load curves, Important terms and factors: connected load, maximum demand, average load, load factor, diversity factor. **Economics of power generation:** fixed cost, semi fixed cost, running cost, Tariff: objective, desirable characteristics, types.	21
II	**Transmission and distribution:** Electric supply system layout, introduction to ac and dc transmission system, comparison, elements of transmission: power transformer, towers, insulators, conductors, cables, distribution transformer; requirements of satisfactory electric supply, overview of distribution system, challenges in power system. **Power factor improvement:** Power triangle, disadvantages of low power factor, causes of low power factor, power factor improvement method, calculation for power factor correction **Electrical loads:** Modelling of load, Electric lighting: Basic parameter used in lighting, various types of lighting sources: Fluorescent lamps, electrical circuitry, CFLs, LED lighting, Lighting design process, Electric Motor: load characteristics, gearing, various applications such as elevator, hybrid electric vehicle (HEV). Introduction to transducers and sensors.	22

Text Books:

1. Mehta V.K. & Mehta Rohit. Principles of Power System (Multicolor Edition).S. Chand, 2005 (illustrated, revised edition).
2. Gross, Charles A., and Thaddeus A. Roppel. Fundamentals of electrical engineering. CRC press, 2012.

Reference Books:

1. Bird, John. Electrical circuit theory and technology. Routledge, 2017
2. Hughes, Edward, et al. Hughes electrical and electronic technology. Pearson education, 2008.

Course Outcome: *at the end of course student will able to,*
CO1: Elaborate and compare conventional and renewable energy power generation.
CO2: Understand the terms as used in load curves.
CO3: Estimate cost of power generation and tariffs.
CO4: Identify role of various components involved in transmission and distribution of electrical power.
CO5: Understand the importance of power factor improvement.

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4,/ PSO1, PSO3
CO2	PO1, PO2, PO3, PO4,/ PSO1, PSO2, PSO3
CO3	PO1, PO2, PO3, PO4,/PSO2, PSO3
CO4	PO1, PO2, PO3, PO4/ PSO2, PSO3
CO5	PO1, PO2, PO3, PO4 /PSO1, PSO3