KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE- 638 060

MINUTES OF THE MEETING OF BOARD OF STUDIES IN ELECTRICAL AND ELECTRONICS ENGINEERING

MEETING No. 21

DATE : 19-06-2021

TIME : 10.00 AM (Online)

Google Meet Id: https://meet.google.com/xdg-zkia-jat

The following members were present for the meeting:

1.	Dr.A.Sheela, Associate Professor & Head, Department of Electrical and Electronics Engineering Kongu Engineering college, Perundurai-638060	Chairman
2.	Dr.P.Thirumoorthi Professor Department of Electrical and Electronics Engineering, Kumaraguru College of Technology, Coimbatore – 641049	University Nominee
3.	Dr. S. Balamurugan Professor Department of Electrical and Electronics Engineering Amrita Vishwa Vidyapeetham, Coimbatore Campus Amritanagar, Coimbatore - 641 112	Academic Council Nominee
4.	Dr.S. Kumaravel Assistant Professor Department of Electrical Engineering, NIT, Calicut, Kerala-673 601.	Academic Council Nominee
5.	Mr.S.Nandhkumar Scientist F, RAD IV, LRDE, DRDO,CV Raman Nagar, Bangalore- 560093	Alumni Representative
6.	Er.S.Yuvaraj Moorthy Associate General Manager – Central Technical Marketing, Strategy & Technology, Schneider Electric India Private Limited, 2nd Floor,Block-2,Bannari Amman Towers,, No.29, Dr.Radhakrishnan Road, Mylapore, Chennai-600004	Industry Representative
7.	Dr.R.Meenakumari	Internal Member
8.	Dr.N.Senthilnathan	Internal Member
9.	Dr.M.Sivachitra	Internal Member
10.	Dr.S.Albert Alexander	Internal Member
11.	Dr.M.Karthik	Internal Member
12.	Dr.P.S.Raghavendran	Internal Member

13.	Dr.S.Usha	Internal Member
14.	Dr.S. Maheswari	Internal Member
15.	Dr.T.Logeswaran	Internal Member
16.	Dr.T. Gunasekar	Internal Member
17.	Mr.S.Chandrasekar	Internal Member
18.	Mr.P. Karthikeyan	Internal Member
19.	Dr.V.Surendar	Internal Member
20.	Dr.N. Priyadharshini	Internal Member
21.	Dr.K.Prithivi	Internal Member
22.	Mr.S.K. Logesh	Internal Member
23.	Ms.S. Gomathy	Internal Member
24.	Mr.R. Ranjith Kumar	Internal Member
25.	Mr.K. Ranjith Kumar	Internal Member
26.	Mr.K.Kavin Mullai	Internal Member
27.	Mr.V. Kumaresan	Internal Member
28.	Mr.M.S.Kamalesh	Internal Member
29.	Mr.M.Sabarimuthu	Internal Member
30.	Dr.M.Srinivasan	Internal Member
31.	Mr.P.Tamilarasu	Internal Member
32.	Mr.P.Sethupathi	Internal Member
33.	Mr.M.Suresh	Internal Member
34.	Mr.D.Sarathkumar	Internal Member
35.	Mr.P.Gowrishankar	Internal Member

The following members were present as special invitees:

-- NIL--

The following members have requested for leave of absence:

-- NIL--

Meeting of the EEE Board:

Chairman/BoS welcomed the members and briefed on the rules and regulations governing the autonomous scheme and presented the agenda points including the draft syllabi from 3rd semester to final semester under Regulation 2020 of UG Programme.

The board discussed and approved the following points as per the agenda:

Item No. 21.1: Confirmation of Minutes of the previous Board of Studies meeting

Resolved to confirm the minutes of the previous Board of Studies Meeting held on 29.08.2020.

Item No. 21.2: Ratification of the following items under R2014 & R2018 as given in Appendix-I.

a. Course and Syllabi for PhD Course work
b. One credit courses
c. On line courses
d. Curriculum and Syllabi amendments under R2014 & R2018
e. Introduction of new electives under R2014 &R2018
f. Credit transfer from Foreign Universities, Change of Regulations for readmitted students, Transferred candidates
g. Other items if any

It is resolved to ratify the above items a, b, c, d, e, f and g as given in Appendix – I.

Item No. 21.3. Approval of the Syllabi from 3rd semester to 8th semester BE/BTech (Electrical and Electronics Engineering under R2020 as given in Annexure-II

The members discussed the syllabi from third semester to Eighth semester BE Electrical and Electronics Engineering under R2020 as given in Annexure – II and approved the same.

Item No. 21.4. Approval for one credit courses, on-line courses with syllabi, Transfer of credits from UGC & AICTE approved institutions and Credit transfer from foreign universities under R2018 & R2020 as given in Annexure-III.

The members discussed the one credit courses, on-line courses with syllabi, Transfer of credits from UGC and AICTE approved institutions including NPTEL, SWAYAM, etc., and Credit transfer from foreign universities under R2018 & R2020 (from the year 2021-22 onwards) as given in Annexure – III and approved the same.

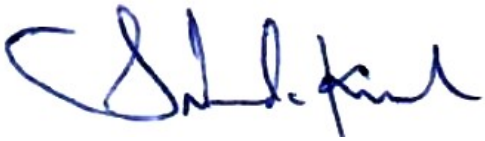
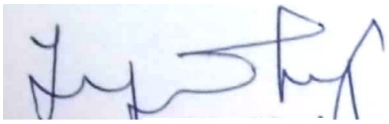
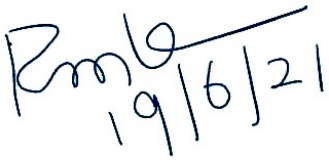
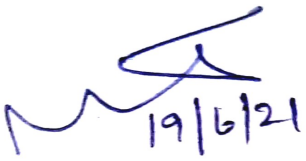
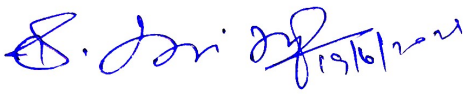
Item No. 21.5. Approval of Syllabus for PhD courses under R2020 as given in Annexure-IV.

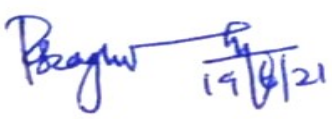
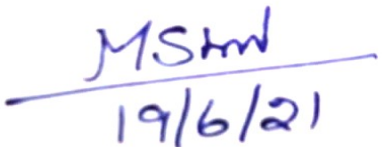
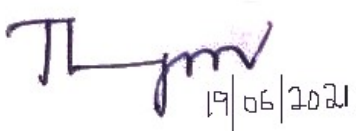
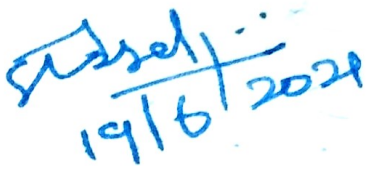
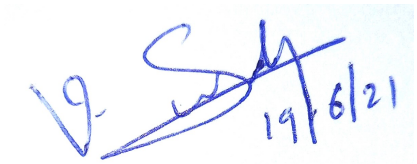
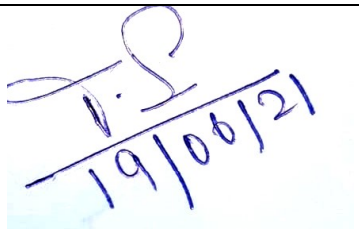
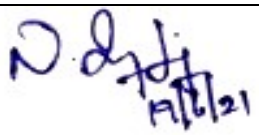
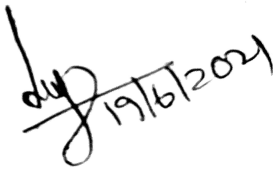
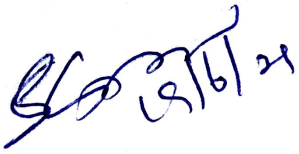
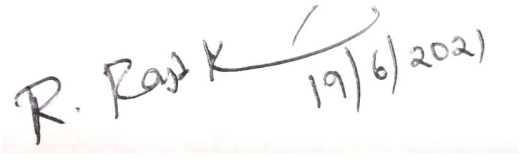
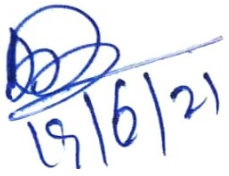
The members discussed the Syllabus for PhD courses under R2020 (if any from the year 2021-22 onwards) as given in Annexure – IV and approved the same.

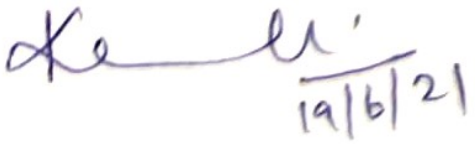
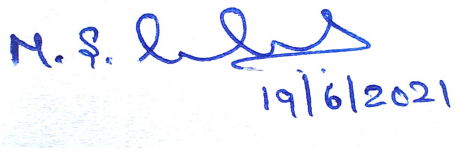
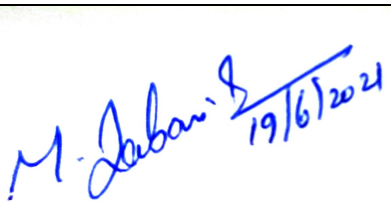
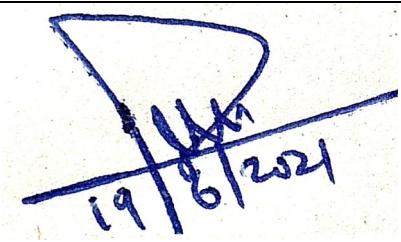
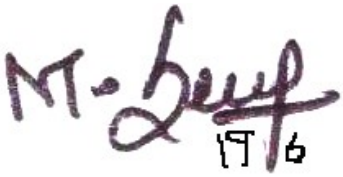
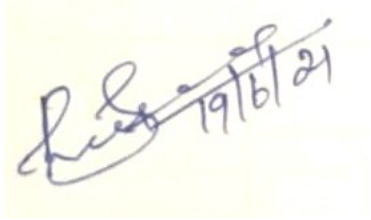
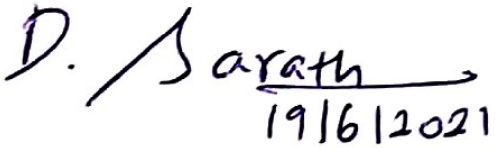
Item No. 21.6. To recommend the online examination system to be followed for the April/May 2021 End Semester Examinations as given in Annexure-V.

The members discussed recommend the online examination system to be followed for the April/May 2021 End Semester Examinations as given in Annexure-V

The meeting was concluded with a vote of thanks to the members.

 Name & Signature Dr.P.Thirumoorthi University Nominee	 Name & Signature Dr. S. Balamurugan Academic Council Nominee
 Name & Signature Dr.S. Kumaravel Academic Council Nominee	 Name & Signature Mr.S.Nandhkumar Alumni Representative
 Name & Signature Er.S.Yuvaraj Moorthy Industry Representative	 Name & Signature Dr.R.Meenakumari
 Name & Signature Dr.N.Senthilnathan	 Name & Signature Dr.M.Sivachitra
 Name & Signature Dr.S.Albert Alexander	 Name & Signature Dr.M.Karthik

 Name & Signature Dr.P.S.Raghavendran	 Name & Signature Dr.S.Usha
 Name & Signature Dr.S.Maheswari	 Name & Signature Dr.T.Logeswaran
 Name & Signature Mr.S.Chandrasekar	 Name & Signature Mr.P.Karthikeyan
 Name & Signature Dr.V.Surendar	 Name & Signature Dr.T. Gunasekar
 Name & Signature Dr.N. Priyadharshini	 Name & Signature Dr.K.Prithivi
 Name & Signature Mr.S.K. Logesh	 Name & Signature Ms.S. Gomathy
 Name & Signature Mr.R. Ranjith Kumar	 Name & Signature Mr.K. Ranjith Kumar

 Name & Signature Ms.K.Kavin Mullai	 Name & Signature Mr.V. Kumaresan
 Name & Signature Mr.M.S.Kamalesh	 Name & Signature Mr.M.Sabarimuthu
 Name & Signature Dr.M.Srinivasan	 Name & Signature Mr.P.Tamilarasu
 Name & Signature Mr.M.Suresh	 Name & Signature Mr.P.Sethupathi
 Name & Signature Mr.D.Sarathkumar	 Name & Signature Mr.P.Gowrishankar
	 Name & Signature Dr.A.Sheela Chairman/BoS

Annexure – I

Ratification items under R2014 & R2018 implemented during the last academic year 2020-21

a. Course and Syllabi for PhD Course work

b. One credit courses

Electrical CAD
Basics of Electronics and Circuit Designing
Real time Embedded System development using high performance ARM CORTEX M4 Processor
Introduction to IoT and its real time applications
Illumination and lighting Design
FPGA Design for Signal and Image Processing

c. On line courses

noc20-cs83/ The Joy of Computing using Python
noc20-ee65/ Introduction to Smart Grid
noc20-cs70/ Programming, Data Structures And Algorithms Using Python
noc20-cs66 / Introduction to internet of things
noc20-ee98/ Introduction to Embedded System Design
noc20-ee95 / Introductory Neuroscience & neuro-Instrumentation
noc20-ee67 / Advances in UHV Transmission and Distribution
Introduction to Embedded System Design
Wheeled Mobile Robots
Introduction to Internet of Things
Real Time Operating System
Data Base Management System

d. Curriculum and Syllabi amendments under R2014 & R2018

e. Introduction of new electives under R2014 &R2018

Introduction of new subject NCC with 4 credit is offered as open elective

f. Credit transfer from Foreign Universities, Change of Regulations for readmitted students, Transferred candidates

g. Other items if any

Changes in R2020

20EEE03 Biomass energy system changed from V semester to VI semester
20EEE08 Renewable Energy System changed from VI semester to V semester
20EEL53 Control System and instrumentation laboratory renamed as 20EEL53 Control System Laboratory
20EET61 Microprocessor and Microcontrollers renamed as Microprocessor and Microcontroller
20EEL62 Microprocessor and Microcontrollers Laboratory renamed as Microprocessor and Microcontrollers Laboratory
20EEE06 Advanced Power Electronics renamed as Advanced Power Electronic Circuits
Introduction of new subject NCC with 4 credit is offered as open elective

PG- Power Electronics and Drives

20PEE26 Energy Storage System changed from IV semester to II semester

Annexure - II

Syllabi from 3rd semester to 8th semester BE/BTech (Electrical and Electronics Engineering) under R2020

20EET31 DC MACHINES AND TRANSFORMERS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	3	1	0	4

Preamble	This course aims in imparting knowledge on construction and working principle of DC machines. It also aims in imparting fundamental knowledge of transformer construction, types, operation and testing concepts required for electrical engineers.	
Unit - I	**Principles of Electromechanical Energy Conversion:**	**9+3**
Review of Magnetic Circuits – Magnetic Circuit Calculations and Magnetization Curves – Energy in Magnetic field System: Energy and Co-energy – Field Energy and Mechanical Force – Singly excited and doubly excited system – Forces/Torques Calculation.		
Unit - II	**DC Generators**	**9+3**
Constructional Details – Working Principle – Types of Armature Winding and Connections – EMF Equation – Methods of Excitation – Characteristics of Series and Shunt Generators – Armature Reaction and Commutation – Losses, Efficiency and Power Stages in DC Generator – Condition for Maximum Efficiency – Applications.		
Unit - III	**DC Motors**	**9+3**
Principle of Operation – Back EMF and Torque Equations – Types of DC Motors – Characteristics of Series, Shunt and Compound Motors – Applications – Starters – Speed Control Methods – Testing of DC Machines – Testing Standards – IEC, NEMA.		
Unit - IV	**Transformers**	**9+3**
Constructional Details – Types – Principle of Operation – EMF Equation – Transformation Ratio – Phasor Diagram – Transformer on No Load and Load – Equivalent Circuit – OC and SC Test – Regulation and Efficiency – Parallel Operation – Auto Transformer – Saving of Copper.		
Unit - V	**Testing of Transformer**	**9+3**
Losses and Efficiency in Transformers – Condition for Maximum Efficiency – Testing of Transformers – Polarity Test, Load Test – Phasing out Test – Sumpner's Test – IEC/IEEE Standard Practices of Testing transformers – Separation of Losses – All day Efficiency – Instrument Transformers – Three Phase Transformers – Types of Connections. Instrument Transformers: Current Transformer – Potential Transformer.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Rajput R.K.,"Electrical Machines", 6th Edition, Laxmi Publications, New Delhi, 2018.

REFERENCES:

1. Kothari D.P. and Nagrath I.J, "Electric Machines", 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2018.
2. Bimbhra P.S, "Electrical Machinery", 7th Edition, Khanna Publishers, New Delhi, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the concepts of magnetic circuits and electromechanical energy conversion	Understanding (K2)
CO2	demonstrate the construction and working principle of DC machines	Applying (K3)
CO3	select suitable starters, speed control and testing methods applicable to DC motors	Understanding (K2)
CO4	determine the performance of transformers	Applying (K3)
CO5	examine the losses and efficiency of transformer by applying various testing methods and select the instrument transformers for relevant power measurement needs	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											1	2
CO2	3	2	1										2	3
CO3	3	1											1	2
CO4	3	2	1	2									2	3
CO5	2	3	1	2	1								3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	15	40	35	10			100
CAT3	15	40	35	10			100
ESE	15	40	35	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET32 ANALOG ELECTRONICS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Electric Circuits and Electron Devices	**3**	**PC**	**3**	**0**	**0**	**3**

Preamble	To examine the basic and design knowledge about electronic circuit analysis using BJT and op-amp which involves feedback, oscillator, high frequency amplifiers and its applications	
Unit - I	**Cascade,Differential and Power Amplifiers**	**9**
h parameters – Hybrid model of BJT – Cascade amplifiers (two-stage) – applications – Differential Amplifier using BJT – Differential and Common Mode Gain, CMRR – Classification of Power Amplifiers – Transformer Coupled Class A, Class B Push Pull Amplifiers		
Unit - II	**Feedback Amplifiers and Oscillators**	**9**
Principle, Advantages of Negative Feedback Amplifiers – Types of Feedback Connections: Voltage / Current, Series/ Shunt Feedback –Classification of Oscillators – Stability of Feedback Circuits using Barkhausen Criteria – Phase Shift and Wien Bridge Oscillators – Colpitts, Hartley Oscillators – Astable and Monostable Multivibrator		
Unit - III	**Operational Amplifier**	**9**
Basic Information of Operational Amplifier – Block Diagram and Internal Circuits of Operational Amplifier – Circuit Schematic of IC741 –Ideal Operational Amplifier Characteristics, Transfer Characteristics – DC Characteristics – AC Characteristics – Frequency Response, Stability – Frequency Compensation Techniques – CMRR and Slew Rate		
Unit - IV	**Basic Op-amp Applications**	**9**
Inverting and Non-Inverting Amplifiers, Voltage Follower – Adder – Subtractor – Instrumentation Amplifier – Differentiator – Integrator –V/I and I/V Converter – Comparator – Regenerative Comparator – Square Wave Generator – Triangular Wave Generator – Schmitt Trigger – VCO- PLL: Basic principle – Filters: LPF,HPF (first order).		
Unit - V	**Special Purpose ICs**	**9**
Timer (IC 555): Functional block, Characteristics of 555 Timer – Application (PWM) - AD623 Instrumentation Amplifier and its application – IC voltage regulators – LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply – LM317, 723 Variable voltage regulators, switching regulator – SMPS.		

Total:45

TEXT BOOK:

1.	R.S.Sedha, "A Textbook of Applied Electronics ", 4th Edition, S.Chand & Co., Ltd, New Delhi, 2014 for Units I,II
2.	Roy Choudhry D. and Shail Jain, " Linear Integrated Circuit ", 5th Edition, New Age International, New Delhi, 2018 for Units III,IV,V

REFERENCES:

1.	Salivahanan. S and Suresh Kumar. N, "Electronic Devices and Circuit ", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017.
2.	Sedra & Smith, “Microelectronics”, 7th Edition, Oxford University Press, 2017

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the working and characteristics of cascade, differential, power amplifiers	Understanding (K2)
CO2	illustrate the operation of feedback amplifiers and oscillators	Understanding (K2)
CO3	describe the construction, characteristics and frequency response of op-amps.	Understanding (K2)
CO4	design and implement the linear applications of Op-Amp	Applying(K3)
CO5	examine and identify the IC's for various applications	Applying(K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1									2	1
CO2	3	2	1	1									2	1
CO3	3	2	1	1									2	1
CO4	2	3	2	1									3	2
CO5	2	3	2	1									3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60					100
CAT2	30	70					100
CAT3	20	60	20				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET33 DIGITAL ELECTRONICS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	PC	3	0	0	3

Preamble	This course aims to impart knowledge on combinational and sequential logic circuits that aids the students to perform analysis and design of various digital logic circuits and also write the verilog HDL code for logic circuit.	
Unit - I	**Review of Number Systems and Logic Families**	**9**
Review of number systems – Number Base conversion – Boolean Algebra – Boolean Laws – De Morgan's Theorem – Boolean Equation – SOP and POS representations and conversions – Logic simplification using Boolean Algebra – Four variable K map – Logic Simplification using K Maps – Don't Cares – NAND and NOR implementation – RTL, DTL, TTL, ECL and CMOS Gates.		
Unit - II	**Combinational Circuits**	**9**
Design Procedure – Binary Addition – Binary Subtraction – Decoders – Encoders – Multiplexers – Demultiplexers – Code Conversion: Gray to Binary, Binary to gray, BCD to Binary, Binary to BCD – Magnitude comparators: 1 bit, 2 bit, 4 bit.		
Unit - III	**Synchronous Sequential Circuits**	**9**
Latches and Flip-flops – Conversion of one type of flip-flop to another type – Operating characteristics of Flip-flops – Analysis of Synchronous sequential circuits: State Table, State Diagram, State Equation – Design procedure of Synchronous sequential circuits – State reduction of synchronous sequential circuits-Design of synchronous up/down counter.		
Unit - IV	**Asynchronous Sequential Circuits**	**9**
Design procedure of Asynchronous sequential circuits – Fundamental mode sequential circuits – Design Procedure for Fundamental mode Asynchronous sequential circuits – Hazards: Static Hazards - Dynamic Hazards – Hazard free Realization – Essential Hazards – Classification of ROM and RAM – PLA– PAL– SPLDS–CPLDS– FPGA.		
Unit - V	**Verilog HDL**	**9**
Overview of Verilog HDL – Hierarchical Modelling Concepts – Basic Concepts – Modules and Ports – Gate level modelling – Gate level description using Verilog HDL for Adders, subtractors, Decoders, Encoders, Multiplexers, Demultiplexers – Magnitude comparators		

Total:45

TEXT BOOK:

1. Soumithra Kumar Mandal, "Digital Electronics Principles and Applications", 11th Reprint Edition, Tata Mc Graw Hill, New Delhi, 2017 for Units I, II,III,IV.
2. Samir Palnitkar, "Verilog HDL: Guide to Digital Design and Synthesis", 2nd Edition, Pearson Education, New Delhi, 2017 for Unit V.

REFERENCES:

1. Anand Kumar.A, "Fundamentals of Digital Circuits" 4th Edition, Prentice Hall of India, Chennai, 2016
2. Morris Mano.M, "Digital Design with an Introduction to the Verilog HDL, VHDL, and System Verilog", 6th Edition, Pearson Education, New Delhi, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	discuss number systems, Boolean rules & laws, logic families and Reduce the Boolean expression.	Understanding (K2)
CO2	illustrate combinational logic circuits using logic gates.	Applying (K3)
CO3	design synchronous sequential circuits using flip-flops.	Analyzing (K4)
CO4	implement asynchronous logic circuits and demonstrate hazards, PLDs	Applying (K3)
CO5	develop Verilog model of combinational circuits using Gate level modelling.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1									1	2
CO2	3	2	1	1									1	2
CO3	2	3	2	2	1								1	2
CO4	3	2	1	1									1	2
CO5	3	2	1	1									1	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	60				100
CAT2	10	10	60	20			100
CAT3	10	10	80				100
ESE	10	20	50	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEL31 DC MACHINES AND TRANSFORMERS LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	PC	0	0	2	1

List of Exercises / Experiments:

1.	Load characteristics of DC series motor.
2.	Speed control of DC shunt motor.
3.	Open circuit and load characteristics of DC shunt generator.
4.	Swinburne's test.
5.	Load test on DC shunt motor.
6.	OC and SC test of transformers.
7.	Separation of losses in 1-phase Transformer.
8.	Sumpner's test.
9.	Load test on three phase transformer.
10.	Computer aided analysis of electrical machines.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	ANSYS Software

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	execute the various methods of speed control in DC machines	Applying(K3), Precision (S3)
CO2	perform suitable tests and analyze the performance of rotating machines and transformers	Applying(K3), Manipulation (S2)
CO3	analyze the machines and estimate the parameters using computer aided tools	Applying(K3), Precision (S3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1									2	3
CO2	2	3	2	2	1								3	2
CO3	2	3	2	2	1								3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

20EEL32 ANALOG AND DIGITAL ELECTRONICS LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	PC	0	0	2	1

List of Exercises / Experiments :

1.	Design of astable multivibrator using BJT.
2.	Design of RC phase shift oscillators using BJT.
3.	Design of integrator and differentiator circuit using op-amp.
4.	Design a monostable multivibrator using Op-Amps /IC 555.
5.	Design of active filters for the given specifications and obtain their frequency response characteristics using op-amps.
6.	Verification of logic gates (Discrete components/Verilog HDL).
7.	Design and implementation of adders and subtractors (Discrete components/Verilog HDL).
8.	Simulation of code converters and flip-flops using Verilog HDL.
9.	Design and implementation of synchronous up and down counters using flip flops.
10.	Study of implementation of combinational/sequential circuit using FPGA.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	Xilinx vivado design tool

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	build and execute oscillators and multivibrators using BJT	Understanding (K2), Imitation(S1)
CO2	construct and implement the linear and nonlinear applications of op-amps	Applying(K3), Manipulation (S2)
CO3	design and simulate the combinational and sequential circuits using Logic gates and verilog HDL.	Analyzing (K4), Manipulation(S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20EET41 SIGNALS AND SYSTEMS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Mathematics III	4	ES	3	1	0	4

Preamble	This course helps the students to impart the knowledge on various types of signals and systems with their mathematical representations, various transformation techniques and their computations.	
Unit - I	**Standard continuous time signals**	**9+3**
Standard continuous time signals –Classification -Mathematical operation on continuous time signals–Impulse signal - Classification of continuous time systems- Convolution of continuous time signals-Response of LTI continuous time system using convolution –Unit step response using convolution - Impulse response and transfer function, Response of LTI CT systems using Laplace transform.		
Unit - II	**Discrete time signals and systems**	**9+3**
Sampling and Aliasing- Standard discrete time signals-Classification of discrete time signal-Mathematical operation on discrete time signal- Classification of discrete time systems - Linear convolution- Representation of discrete time signals as summation of impulses-Response of LTI discrete time systems using discrete convolution-Convolution properties-Computation of linear convolution using matrix method - Circular convolution- Computation of circular convolution using matrix method.		
Unit - III	**Z transform**	**9+3**
Z-transform of DT signals and systems – Region of convergence – Properties of Z transform and ROC- Inverse Z transform using partial fraction method – Impulse response and transfer function – Convolution and de-convolution using Z transform – Stability in Z-domain – Relation between Laplace transform and Z transform.		
Unit - IV	**Fourier Transform**	**9+3**
Fourier transform – Properties of FT – FT of CT signals – Relation between Fourier and Laplace transform – Fourier transform of discrete time signals – Properties of DTFT – Relation between Fourier transform and Z-transform.		
Unit - V	**Discrete Fourier Transform of discrete time signals**	**9+3**
Discrete Fourier Transform of discrete time signals – Fast Fourier Transform – Decimation In Time (DIT) radix-2 FFT – Decimation In Frequency (DIF) radix-2 FFT – computation of inverse DFT using FFT.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Nagoor Kani. A ,“Signals and Systems”, 2nd Reprint, Tata McGraw-Hill Education, New Delhi, 2010

REFERENCES:

1. Salivahanan. S, “Digital Signal Processing”, 4th Edition, Tata McGraw Hill Education, New Delhi, 2019
2. John.G.Proakis, Dimitris.G.Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, 5th Edition, Pearson Education, India, 2021

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify the various types of continuous signals and systems with mathematical background	Applying(K3)
CO2	compare various types of discrete time signals and systems.	Applying(K3)
CO3	interpret the importance of Z-transform in DT signals and systems.	Applying(K3)
CO4	analyze CT and DT signals in frequency domain	Analyzing (K4)
CO5	apply DFT using FFT on various discrete time signals	Applying(K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1									2	3
CO2	3	2	1	1									2	3
CO3	3	2	1	1									2	3
CO4	2	3	2	2	1								3	2
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	50	20			100
ESE	10	20	50	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET42 SYNCHRONOUS AND INDUCTION MACHINES

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	DC Machines and Transformers	4	PC	3	0	0	3

Preamble	This course aims in imparting knowledge on construction and working principle of AC machines and some special electrical machines. It also explores on various methods of speed control of AC machines.	
Unit - I	**Alternator**	**9**
Introduction to Rotating MMF – Construction and Operation Details – Types of Rotors – EMF Equation – Synchronous Reactance – Armature Reaction – Voltage Regulation: EMF, MMF and ZPF Methods – Synchronizing and Parallel Operation – Synchronizing Power – Power Output Equations – Change of Excitation and Mechanical Input		
Unit - II	**Synchronous Motor**	**9**
Principle of Operation – Torque Equation – Starting Methods – Operation on Infinite Bus bars – V and Inverted V Curves – Input and Output Power Equations – Power/Power Angle Relations – Hunting – Causes & Prevention – Applications: Synchronous Condenser – Power factor correction.		
Unit - III	**Three Phase Induction Motor**	**9**
Construction and Operation Details – Types of Rotors – Squirrel Cage and Slip Ring – Slip –Torque Equations – Slip Torque Characteristics – Losses and Efficiency – Load Test – No Load and Blocked Rotor Tests – Equivalent Circuit – Circle Diagram – Separation of No Load Losses – Crawling and Cogging – Double Cage Rotors – Induction Generator – Applications.		
Unit - IV	**Starting and Speed Control of Three Phase Induction Motor**	**9**
Need for Starters – Types of Starters – Rotor Resistance, Autotransformer, Star-Delta and DOL Starters – Speed Control by Varying Voltage, Frequency, Poles and Rotor Resistance – Slip Power Recovery Scheme.		
Unit - V	**Single Phase Induction Motors and Special Machines**	**9**
Construction and Operation Details – Double Revolving Field Theory – Equivalent Circuit – Simple Problems Starting Methods: Split Phase, Capacitor Start, and run, Shaded Pole – Applications – Servo Motor, Stepper Motor and Universal Motor		

Total:45

TEXT BOOK:

1. Rajput R.K., "Electrical Machines”, 6th Edition, Laxmi Publications, New Delhi, 2018.

REFERENCES:

1. Kothari D.P & Nagrath I.J, "Electric Machines", 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2018.
2. Gupta J.B., “Electrical Machines”, 4th Edition, S.K. Kataria & Sons, New Delhi, Reprint 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the basic constructional and working principle of synchronous and induction machines	Understanding (K2)
CO2	compute the performance of AC machines with different parameters	Applying (K3)
CO3	analyze the performance characteristics of induction machines	Analyzing (K4)
CO4	apply starting and speed control methods to AC motors	Applying (K3)
CO5	demonstrate the operation of single phase induction machine and special electrical machines	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											1	2
CO2	3	2	1	1									2	3
CO3	2	3	2	2	1								3	2
CO4	3	2	1	1									2	3
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	50	40				100
CAT2	10	50	30	10			100
CAT3	10	60	30				100
ESE	15	50	25	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET43 ELECTROMAGNETIC THEORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	4	PC	3	0	0	3

Preamble	This course explores the concepts of static electric, static magnetic and electromagnetic fields and its applications	
Unit - I	**Introduction to Vector Algebra and Electric Fields**	**9**
Scalar and Vector Fields – Calculus of Scalar and Vector Fields in Cartesian and Curvilinear Coordinates – Divergence – Divergence Theorem – Curl – Stoke's Theorem. **Coulomb's law and Electric field intensity:** Electric Charge – Types of Charge Distribution – Coulomb's Law – Electric Field Intensity Due to Point Charge, Line Charge and Surface Charge Distribution.		
Unit - II	**Electrostatics**	**9**
Electric Flux Density, Gauss's Law and Potential: Electric Flux Density – Gauss's Law – Application of Gauss's Law – Potential Difference – Potential – Conservative Property – Potential Gradient – Energy Stored. Conductors, **Dielectrics and Capacitors:** Conduction Current, Displacement Current – Polarization – Law of Continuity – Boundary Condition: Conductor-Dielectric and Dielectric-Dielectric – Capacitors: Parallel Plate, Transmission Line – Poisson's and Laplace's Equations.		
Unit - III	**Magnetostatics fields**	**9**
Steady Magnetic Fields: Biot-Savart's Law – Ampere's Circuital Law – Magnetic Field due Straight Conductors , Circular Loop – Magnetic Flux – Magnetic Flux Density – Energy Stored. **Force and Inductance:** Magnetic Force, Moving Charge in a Magnetic Field, Lorentz Force – Force Between Two Parallel Current Carrying Conductors – Magnetic Boundary Conditions – Magnetic Circuit – Self and Mutual Inductance – Inductance of Solenoid		
Unit - IV	**Electromagnetics**	**9**
Time varying fields: Time Varying Fields – Transformer and Rotational EMF. Maxwell's equation: Maxwell's Equation in Point Form and Integral Form – Comparison of Circuit Theory with Field Theory **Electromagnetic Waves (Elementary Ideas only**): Introduction – Wave Equations and Parameters – Wave Propagation in Lossless Dielectrics and Lossy Dielectric(Qualitative analysis) – Poynting vector, Poynting Theorem, Introduction to FEM analysis.		
Unit - V	**Electromagnetic Interference and Compatibility (Theoretical Aspects only)**	**9**
Introduction to Electromagnetic Interference and Electromagnetic Compatibility (EMI & EMC) – Sources and Characteristics of EMI – Control Techniques of EMI – Grounding – Shielding – Filtering		

Total:45

TEXT BOOK:

1. Sadiku Matthew N.O., "Principles of Electromagnetics", 6th Edition, Oxford University Press, New Delhi, 2015.

REFERENCES:

1. Hayt Jr W.H., Buck J.A., Jaleel Akhtar M., "Engineering Electromagnetics" , 9th Edition McGraw Hill Education, India, 2020.
2. Gottapu Sasibhushana Rao., "Electromagnetic Field Theory and Transmission Lines", 1st Edition, John Wiley and sons, India, 2013

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	recognize the various coordinate systems and charge distribution	Understanding (K2)
CO2	apply Gauss's law for the evaluation of EFI for different configurations and its application in capacitor	Applying (K3)
CO3	interpret the MFI and inductance for different configurations	Applying (K3)
CO4	examine the electromagnetic wave propagation in different mediums	Applying (K3)
CO5	summarize the sources of EMI and the control techniques to reduce EMI	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	3
CO2	3	2	1										2	3
CO3	3	2	1										2	3
CO4	3	2	1										2	3
CO5	3	2											2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20				100
CAT2	20	50	30				100
CAT3	30	50	20				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET44 GENERATION, TRANSMISSION AND DISTRIBUTION

Programme& Branch	B.E. & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Physics	4	PC	3	1	0	4

Preamble	This course is aimed to introduce the fundamental concepts and principles in generation, transmission, and distribution of electric power	
Unit - I	**Generation**	**9+3**
Structure of power system – Indian energy scenario – Load duration curve – Demand factor – Plant capacity – Plant Use factor – Tariff – Types – Conventional source of electrical energy – schematic arrangement of thermal power generation – fuel handling – Ash handling – dust collection – auxiliaries – schematic arrangement of hydroelectric power generation – Classification – IE Rules		
Unit - II	**Electrical Design of Transmission Lines**	**9+3**
Parameters of Transmission Line – Resistance – Skin and Proximity Effects – Solid, Stranded and Bundled Conductors – Inductance and Capacitance of Single and Three Phase Transmission Lines with Single Circuit – Double Circuit (Solid conductor) – Symmetrical and Unsymmetrical Spacing and Transposition		
Unit - III	**Analysis of Transmission Lines**	**9+3**
Short Line, Medium Line (PI model) and Long Line; Equivalent Circuits, Transmission Efficiency and Voltage Regulation – Attenuation Constant, Phase Constant, Surge Impedance, Surge Impedance Loading – Ferranti Effect Corona: Phenomena of Corona – Factors Affecting Corona – Disruptive Critical Voltage – Visual Critical Voltage – Corona Loss (Qualitative analysis)		
Unit - IV	**Mechanical Design of Transmission Lines**	**9+3**
Insulators: Types, Voltage Distribution in Insulator String and Grading, Improvement of String Efficiency – Failure of Insulators Sag and Tension Calculations: Classification of towers, Sag and Tension in OH lines – Equation of Sag-Calculation of Sag – Towers at Equal Heights – Unequal Heights		
Unit - V	**Distribution Systems**	**9+3**
Components of Distribution System – Types – DC Distribution: DC Distributor – Concentrated and Uniform Loading. AC Distribution: AC Distributor – Concentrated Load – Three Phase Four Wire Distribution System – Sub Mains – Stepped and Tapered Mains - Kelvin's Law. Underground Cables: Constructional Features of LT and HT Cables, Capacitance, Dielectric Stress and Grading, Thermal Characteristics(Qualitative analysis) – Cable Faults and Testing		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Gupta J.B "A Course in Power Systems", 11th Edition, S.K.Kataria& Sons, New Delhi, 2017.

REFERENCES:

1. Wadhwa C.L "Electrical Power Systems", 7th Edition, New Age International Publishers, New Delhi, 2017.
2. Kothari D.P &Nagrath I.J "Power System Engineering", 3rd Edition, McGraw Hill Education, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the various types of generation systems	Understanding (K2)
CO2	apply the transmission network parameters for various configurations	Applying (K3)
CO3	examine the performance characteristics of the given transmission line and explain the effect of corona	Applying (K3)
CO4	solve string efficiency of the insulators and Sag of an overhead line for various conditions	Applying (K3)
CO5	calculate the voltage at a point on the given type of distribution system and compute the insulation resistance, capacitance and grading of cables	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	2
CO5	3	2	1										3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEL41 SYNCHRONOUS AND INDUCTION MACHINES LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	PC	0	0	2	1

List of Exercises / Experiments :

1.	Regulation of three-phase alternator by EMF method.
2.	Regulation of three-phase alternator by MMF method.
3.	Regulation of three-phase alternator by ZPF method.
4.	Synchronizing and load/power sharing of alternators.
5.	V and inverted V curves of three phase synchronous motor.
6.	Load test on single phase and three phase cage induction motors.
7.	Speed control of three phase induction motor.
8.	No load and blocked rotor test on induction motors (1Φ equivalent circuit) – Virtual Lab.
9.	Performance study of induction generator.
10.	Analysis of AC machines using software tools.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	Virtual Laboratory

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	evaluate the performance and select the rotating machines based on their characteristic curves of AC machines	Analyzing (K4), Manipulation (S2)
CO2	predict the regulation and demonstrate the synchronization of two alternators for its power sharing	Applying (K3), Precision (S3)
CO3	utilize the knowledge on computer-aided engineering design of AC machines	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20EEL42 SIGNALS AND SYSTEMS LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	PC	0	0	2	1

List of Exercises / Experiments :

1.	Generation and analysis of Continuous time Signals.
2.	Generation and analysis of Discrete time Signals.
3.	Demonstration of various signal processing operations of continuous and discrete time signals.
4.	Verification of Sampling theorem.
5.	Verification of Linear and Circular Convolution.
6.	Determination of linearity and shift invariance of a discrete time systems.
7.	Determination of stability of LTI system responses.
8.	Analysis of signals using Fourier transforms.
9.	Symmetric and anti-symmetric signal generation using DSP Processor .
10.	Analysis of spectrogram of the real time audio signal.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	MATLAB Software
3.	TMS320C5416 DSP Trainer Kit

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop program using MATLAB for processing the signals and determine the response for various discrete systems.	Applying (K3) Manipulation (S2)
CO2	analyze the signals using Fourier transform.	Analyzing (K4) Manipulation (S2)
CO3	generate and analyze signals using DSP processor kit	Applying (K3) Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20EET51 Power Electronics

Programme& Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Analog Electronics	5	PC	3	0	0	3

Preamble	This course is designed to impart knowledge about the characteristics of power semiconductor devices, working principle of rectifier, chopper , DC to AC converter and AC to AC converter	
Unit - I	**Power Semi Conductor Devices**	**9**
Introduction – Power Diode – Power BJT – Power MOSFET and IGBT - SCR - TRIAC - GTO - Construction, Principle of operation, Static and Dynamic characteristics - Thyristor Protection – Series and parallel connections of thyristors – Data sheet interpretation		
Unit - II	**Single Phase AC to DC Converters**	**9**
Introduction to uncontrolled rectifier – Single Phase and three phase Controlled Rectifiers with R, RL, RL with freewheeling diode and RLE Load – Estimation of performance parameter: RMS load voltage, RMS load current, Power Factor and Distortion Factor – Effect of source inductance – PWM Rectifier.		
Unit - III	**DC to DC Converters**	**9**
Principle of Step Up and Down Chopper – Chopper Control Strategies – Quadrant of Operation: single quadrant, two quadrant and four quadrant DC Choppers – Introduction to Voltage regulator – Buck, Boost, Buck – Boost – Cuk Regulator – SMPS.		
Unit - IV	**DC to AC Converters**	**9**
Single Phase Bridge Inverters – Three Phase Bridge Inverters: 180o and 120o Mode of operation – voltage control of single phase inverter - PWM Inverters: Single, Sinusoidal and Multiple PWM technique – Reduction of harmonics in the inverter output voltage – CSI: Single phase CSI – Basic series inverter – UPS.		
Unit - V	**AC Voltage Controllers and Cycloconverters**	**9**
Principle of AC voltage controller (phase control) – Control Strategy (Integral cycle control) – Single Phase AC Voltage Controllers – Cycloconverters: Principle of cycloconverter (operation) – Single Phase to Single Phase Cycloconverter: step down and step up, Midpoint and Bridge – Three Phase to Single Phase Cycloconverter – OLTC.		

Total:45

TEXT BOOK:

1. Bimbra P.S., "Power Electronics", 6th Edition, Khanna Publishers, New Delhi, 2015.

REFERENCES:

1. Singh M.D. and Kanchandani, "Power Electronics", 2nd Edition, Tata McGraw-Hill, New Delhi, 2016.
2. Rashid M.H., "Power Electronics: Circuits Devices and Applications", 4th Edition, Pearson Education, New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	choose various power semiconductor devices based on their construction, operation and characteristics	Understanding (K2)
CO2	explain the working principle of single phase and three phase rectifier and compute its performance parameter	Applying (K3)
CO3	classify and explain the operation of DC to DC converters	Understanding (K2)
CO4	inspect the operation of different type of inverters	Applying (K3)
CO5	categorize different type of AC voltage controllers and cycloconverters	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											3	2
CO2	3	2	1	1									2	3
CO3	3	1	1										2	3
CO4	3	2	1	1									1	3
CO5	3	1	1										2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET52 POWER SYSTEM ANALYSIS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Electromagnetic Theory, Generation, Transmission and Distribution	5	PC	3	0	0	3

Preamble	This course imparts knowledge about the modeling of power system components, load flow analysis and stability analysis. The course also describes the various types of faults occurs in power system	
Unit - I	**Modeling of Power System**	**9**
Introduction – per unit quantities – changing the base of per unit quantities-one line diagram – impedance and reactance diagram – per unit impedances of a generator, transformer, synchronous machines, transmission lines – per phase representation.		
Unit - II	**Load Flow studies**	**9**
The bus admittance matrix, network incidence matrix and node elimination, power flow problem, Gauss-Siedel method, Newton-Raphson method, Fast Decoupled Load Flow method, Numerical solution of power flow problem by GS method upto three buses		
Unit - III	**Symmetrical Faults in Electrical systems**	**9**
Types of Fault – Need for short circuit study – bus impedance matrices – symmetrical fault analysis – fault calculation using Thevenin's Theorem – fault calculations using Z-bus – selection of circuit breakers		
Unit - IV	**Unsymmetrical Faults in Electrical systems**	**9**
Synthesis of unsymmetrical phasors from their symmetrical components – sequence impedance and sequence network of power system, synchronous machine, transmission lines and transformers. single line-to -ground fault, line-to- line fault, double line-to- ground fault.		
Unit - V	**Stability Analysis**	**9**
Introduction to power system stability – Rotor dynamics and the Swing equation – power angle equation – equal area criterion of stability – Critical clearing angle and time – transient stability studies – factors affecting transient stability. – Multimachine stability studies: classical representation – step by step solution of the swing curve.		

Total:45

TEXT BOOK:

1. Debapriya Das," Electrical Power Systems", 1st Edition, New Age International Publishers Pvt. Ltd, New Delhi, 2006

REFERENCES:

1. Grainger John J.& Stevenson W.D, "Power System Analysis", 1st Edition, Tata McGraw- Hill, New Delhi, 2017.
2. Nagrath I.J.& Kothari D.P, "Modern Power System Analysis", 4th Edition, Tata McGraw- Hill, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	model various power system components	Understanding (K2)
CO2	evaluate the bus powers, line flows and line losses using various power flow methods	Applying (K3)
CO3	calculate the symmetrical fault currents	Applying (K3)
CO4	analyze the different types of unsymmetrical faults	Applying (K3)
CO5	predict the stability of the power system	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											3	1
CO2	3	2	1	1	1								3	2
CO3	3	2	1	1	1								3	2
CO4	3	2	1	1	1								3	2
CO5	3	1											3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	30	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET53 CONTROL SYSTEMS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	3	0	0	3

Preamble	The aim of the subject is to give an adequate exposure to transfer function model, State Space model, Stability analysis, compensator and controller design	
Unit - I	**Systems and Representation**	**9**
Basic Elements in Control Systems: Open and Closed Loop Systems – Transfer Function of Electrical, Mechanical and Thermal Systems – Force – Current and Force – Voltage Analogy of Systems – AC and DC Servomotors – Block Diagram Reduction Techniques – Signal Flow Graphs		
Unit - II	**Time Domain Analysis**	**9**
Standard Test Signals – Steady State Error and Error Constants – Type and Order of Systems – Time Domain Specifications – Effects of Addition of Poles and Zeros – Dominant Poles – Routh Hurwitz Stability Criterion		
Unit - III	**Frequency Response**	**9**
Bode Plot – Polar Plot – Nyquist Stability Criterion – Correlation between Frequency Domain and Time Domain Specifications		
Unit - IV	**Controller and Compensator Design**	**9**
Root Locus Plots of Typical Systems – Root Locus Analysis - P, PI, PD and PID – Effects of P, PI, PID modes of Feedback Control – Design of Lag, Lead, lead-lag Compensator using Root Locus Plots		
Unit - V	**State Variable Analysis**	**9**
Concept of State Variables – State Models for Linear and Time Invariant Systems – Solution of State and Output Equation in Controllable Canonical Form – Concepts of Controllability and Observability		

Total:45

TEXT BOOK:

1. Nagarath, I.J. & Gopal, M., “Control Systems Engineering”, 6th Edition, New Age International Pvt.Ltd, New Delhi, 2017

REFERENCES:

1. Katsuhiko Ogata, “Modern Control Engineering”, 5th Edition ,Pearson, New Delhi, 2015
2. Benjamin C. Kuo, Automatic Control Systems, 10th Edition, Mc Graw Hill Education, New Delhi, 2017

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	develop mathematical model of electrical , mechanical and thermal system	Applying (K3)
CO2	analyze various steady state errors and time domain specifications for the continuous systems	Analyzing(K4)
CO3	examine the stability of the systems using various techniques	Analyzing(K4)
CO4	design appropriate compensator and controller for the given specifications	Applying (K3)
CO5	develop the mathematical model of linear continuous control systems using state space models	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											2	1
CO2	3	2	1	1	1								3	2
CO3	3	2	1	1	1								3	2
CO4	3	2	1	1	1								3	2
CO5	3	1											2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	30	20			100
CAT2	20	30	30	20			100
CAT3	20	30	30	20			100
ESE	20	30	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEL51 POWER ELECTRONICS LABORATORY

Programme& Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PC	0	0	2	1

List of Exercises / Experiments:

1.	Steady state characteristics of SCR.
2.	Single Phase Half controlled and Fully controlled rectifiers.
3.	Three Phase fully controlled rectifiers.
4.	Step down and step up converter.
5.	Three Phase inverters – 180° and 120° mode of operation.
6.	Three Phase AC voltage controller.
7.	Simulation of DC converters (Single phase, three phase controlled converters and choppers).
8.	Simulation of AC converters (Inverter and AC voltage regulator).
9.	PWM signal generation using DSPACE.
10	Design of converter.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	MATLAB Software
3.	DSPACE, PSIM software and Power quality analyzer

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	examine and estimate the performance of AC and DC converters	Analyzing (K4), Manipulation (S2)
CO2	demonstrate and execute the performance of Inverter and AC voltage controller	Analyzing (K4), Manipulation (S2)
CO3	design and build a suitable power converter	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20EEL52 POWER SYSTEMS ANALYSIS LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Electromagnetic Theory,Generation, Transmission and Distribution	5	PC	0	0	2	1

List of Exercises / Experiments :

1.	Computation of line parameters for single and double circuits.
2.	Modeling of medium transmission lines.
3.	Experimental analysis of transmission line.
4.	Analysis of Ferranti effect.
5.	Analysis of Surge impedance loading.
6.	Formation of bus admittance matrices using Direct inspection method.
7.	Formation of impedance matrices using Z bus building algorithm.
8.	Load flow analysis using Gauss Seidal method.
9.	Symmetrical and Unsymmetrical fault analysis.
10.	Transient and small signal stability analysis: Single-Machine infinite bus system.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	MATLAB,AU power, Mi-power Software

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	compute the line parameters and evaluate the performance indices	Applying (K3), Manipulation (S2)
CO2	analyze the network matrices to carryout various power system studies	Analyzing (K4), Manipulation (S2)
CO3	compute the stability of the power system and carryout power system studies	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20EEL53 CONTROL SYSTEM LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PC	0	0	2	1

List of Exercises / Experiments :

1.	Determination of Transfer Function Parameters of DC Servomotor.
2.	Determination of Transfer Function Parameters of AC Servomotor.
3.	Analysis of second order time domain specifications of system using MATLAB.
4.	Effect of Addition of Poles and Zeros on System Stability using MATLAB.
5.	Frequency domain analysis with bode plot using MATLAB.
6.	Effect of P,PI,PID controllers on time response of system using MATLAB.
7.	Design and implementation of compensators via root locus using MATLAB.
8.	Stability analysis in time and frequency domain using MATLAB.
9.	State space analysis of second order systems using MATLAB.
10.	Design and implementation of simple controller for real time application.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	estimate the transfer function of AC and DC servo motor and to analyze the time and frequency response	Analyzing (K4), Manipulation (S2)
CO2	design controller and compensator for the given specifications	Analyzing (K4), Manipulation (S2)
CO3	analyze the stability of the systems and to represent its state space model	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20EET61 MICROPROCESSOR AND MICROCONTROLLER

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Digital Electronics	6	PC	3	0	0	3

Preamble	To get acquaintance with the architecture of 8085 processor and 8051 controller, apply the embedded programming concepts for interfacing peripherals with the controller and to understand the applications of microcontrollers	
Unit - I	**8085 Microprocessor**	**9**
Introduction to 8085 Microprocessor – Architecture – Pin configuration – Interrupts – Instruction Set – Addressing Modes – Timing Diagrams – Memory Interfacing – Simple Assembly Language Programs for arithmetic operations.		
Unit - II	**8051 Microcontroller**	**9**
Introduction to 8051 Microcontroller – Architecture – Memory Organization–Special Function Registers – Program Counter – PSW register – Stack – Instruction set – Addressing modes.		
Unit - III	**8051 Programming**	**9**
I/O Ports – Timer (Mode1) / Counter – Serial Communication – Interrupt (Timer, Serial communication) – Programming in Embedded C: I/O port programming –Timer programming-Counter programming – Serial port programming – Interrupt programming.		
Unit - IV	**Interfacing I/O Peripherals with 8051**	**9**
Programming in Embedded C: LED – Push button switch – Necessity of Relay and Opto-coupler – Keypad – LCD – Seven segments LED – A/D and D/A converters – DC Motor – Stepper motor.		
Unit - V	**Case Study Applications**	**9**
Microcontroller based Washing machine Control – Central Heating System Using a Super Loop – RS232 Serial communication: MAX 232 for I/O text message communication – Microcontroller based Calculator with extended features using MAX232. Simple Street Light control system, Water Level Indicator and Burglar Alarm System – Mobile phone controlled ROBOT (Block diagram with programming approach).		

Total:45

TEXT BOOK:

1. Soumitra Kumar Mandal, "Microprocessors and Microcontrollers Architecture, Programming and System Design 8085,8086 and 8051", 8th Edition, Tata McGraw Hill Education (India) Pvt. Ltd, New Delhi, 2013 for Unit I.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi & Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", 2nd Edition, Pearson Education, New Delhi, 2013 for Units II,III, IV.

REFERENCES:

1. Krishna Kant, "Microprocessors and Microcontrollers: Architecture, programming and system design 8085, 8086, 8051, 8096", 2nd Edition, PHI Learning Pvt. Ltd, New Delhi, 2012.
2. Subrata Ghoshal, “8051 Microcontrollers, 2/e: Internals, Instructions, Programming &Interfacing”, 2nd Edition, Pearson Education, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basic concepts of 8085 microprocessor	Understanding (K2)
CO2	summarize the basic concepts of 8051 microcontroller	Understanding (K2)
CO3	develop embedded c programs for 8051	Applying (K3)
CO4	interface peripheral devices with 8051 microcontroller	Applying (K3)
CO5	recognize microcontroller based case study applications	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											3	2
CO2	3	2											3	2
CO3	3	2	1	1	1								1	3
CO4	3	2	1	1	1								1	3
CO5	3	2											3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	85					100
CAT2	10	45	45				100
CAT3	10	45	45				100
ESE	5	50	45				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET62 POWER SYSTEM PROTECTION AND SWITCHGEAR

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Generation, Transmission and Distribution	6	PC	3	0	0	3

Preamble	The objective of the course is to impact knowledge about the need for protective relays in power systems, protective relays used for the protection of Generators, Transmission line, and Transformers. The course will also describe the various types of circuit breakers and advanced relays used in power system.	
Unit - I	**Introduction**	**9**
Protective Relays: Need for protection – Zones of protection – Power System Earthing –Types of earthing – Classification of relay: Electromagnetic relays, Over current relays – Distance relay: Impedance, Reactance, Mho Relay – Differential relays – Negative phase sequence relay – Relay coordination		
Unit - II	**Protection of Power Equipment**	**9**
Generator protection: Stator protection: Percentage differential protection – stator inter-turn protection -– Stator overheating protection. Rotor protection: Earth fault protection – Loss of excitation – Rotor overheating protection. Transmission line protection: Protection of feeder and ring main system – Pilot wire protection – Carrier current protection – Transformer protection: Incipient fault Protection – Differential protection – over fluxing protection		
Unit - III	**Theory of Circuit Interruption**	**9**
Physics of arc phenomena and arc interruption – Methods of arc Extinction – Theories of arc interruption – Arc voltage – Restriking voltage and recovery voltage – Expression for Restriking voltage and Rate of Rise of Restriking Voltage – Current chopping – interruption of capacitive currents – Resistance switching		
Unit - IV	**Circuit Breakers**	**9**
Classification of circuit breakers – Circuit breaker operating mechanism: Oil, Air Blast, SF6, Vacuum – DC circuit breaker – Selection of C.B. – Comparative merits of different circuit breakers – Testing of C.B: Type test and Routine test – Direct testing – Indirect testing.		
Unit - V	**Advanced relays**	**9**
Introduction of microprocessor based protective relay – Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relay – Digital signal processing in numerical relay – Digital Filtering – Numerical Over current protection – Numerical Transformer Differential Protection – Numerical distance protection of transmission line – Arc flash relays – Shielded solid insulation switchgear – Green switchgear.		

Total:45

TEXT BOOK:

1. Gupta J.B, "A Course in Power Systems", 11th Edition, S.K.Kataria & Sons, New Delhi, 2017 for Units I, II, III, IV.
2. Paithankar Y.G & Bhide S.R, “Fundamentals of Power System Protection”, 2nd Edition, Prentice–PHI Learning Private Limited, 2010 for Unit V.

REFERENCES:

1. Badri Ram & Vishwakarma D.N, "Power System Protection and Switchgear", 2nd Edition, Tata McGraw Hill, New Delhi, 2011.
2. Madhava Rao T.S, “Digital/Numerical Relays”, 1st Edition, Tata McGraw Hill, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the basic concepts of protection	Understanding (K2)
CO2	select the protection schemes for power system components	Applying (K3)
CO3	analyze the various problems in circuit interruption	Applying (K3)
CO4	compare the different type of circuit breakers performances	Understanding (K2)
CO5	understand the advanced relays	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											3	1
CO2	3	2	1	1	1								3	2
CO3	3	2	1	1	1								3	2
CO4	3	1											3	1
CO5	3	1											3	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	30	70					100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET63 ELECTRIC DRIVES AND CONTROL

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	DC Machines and Transformers, Synchronous and Induction Machines, Control System, Power Electronics	6	PC	3	0	0	3

Preamble	This course aims in imparting knowledge about various DC and AC drives and selection of drives for various applications	
Unit - I	**Introduction to Electric Drives**	**9**
Electrical drives – Advantages of Electrical Drives – Choice of Electrical drives – Fundamental torque equation – speed torque conventions and multiquadrant operation – components of load torque – nature and classification of load torque – Modes of operation – Speed control and drive classification – closed loop control of drives – classes of motor duty – determination of motor rating.		
Unit - II	**Converter/Chopper Fed DC Motor Drives**	**9**
DC motor and their performance – Braking – controlled rectifier fed DC drives – single phase and three phase fully controlled rectifier control of dc separately excited motor – multiquadrant operation of DC separately excited motor fed from fully controlled rectifier – chopper controlled DC drives – chopper control of separately excited DC motors – source current harmonics in chopper.		
Unit - III	**Induction Motor Drives**	**9**
Analysis and performance of three phase induction motor – Stator voltage control – Variable frequency control from voltage sources – Voltage source inverter(VSI) control – cycloconverter control – closed loop speed control and converter rating for VSI and cycloconverter induction motor drives – Rotor resistance control-slip power recovery.		
Unit - IV	**Synchronous Motor Drives**	**9**
Types-synchronous motor variable speed drives – variable frequency control – modes of variable frequency control – self-controlled synchronous motor drive employing load commutated thyristor inverter – self-controlled synchronous motor drive employing a cycloconverter – Permanent magnet (PM) ac motor drives.		
Unit - V	**BLDC, Stepper Motor Drives and Applications**	**9**
Brushless DC motor drives – Variable reluctance and permanent magnet stepper motor Drives – Solar and Battery powered drives – drives for specific applications – drive considerations for textile mills – cranes and hoist drives – paper mills – centrifugal pumps.		

Total:45

TEXT BOOK:

1. Dubey G.K. "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2019.

REFERENCES:

1. Vedam Subrahmanyam "Electric Drives: Concepts and Applications", 2nd Edition, McGraw-Hill, New Delhi, 2010.
2. Bose B.K. "Power Electronics and Variable Frequency Drives: Technology and Applications", 1st Edition, Wiley India Pvt. Ltd., , New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	analyse the motor load characteristics	Applying (K3)
CO2	apply power converters for speed control of DC drives	Applying (K3)
CO3	understand the operation and control of Induction motor drives	Understanding (K2)
CO4	analyse the performance of synchronous motor drives	Applying (K3)
CO5	understand the operation of special electrical machines and control schemes for various industrial applications	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1									2	3
CO2	3	2	1	1									2	3
CO3	3	1											1	2
CO4	3	2	1	1									2	3
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	50	40				100
CAT2	10	60	30				100
CAT3	10	60	30				100
ESE	10	60	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEL61 PROTECTION AND RES LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	PC	0	0	2	1

List of Exercises / Experiments :

1.	Characteristics of over current/ overvoltage relay.
2.	Bias characteristics of differential relay.
3.	Characteristics of negative sequence relay.
4.	Study of Buchholz relay, MCB, ELCB.
5.	Measurement of breakdown voltage of liquid dielectric.
6.	VI Characterization study of PEM fuel cell stack system.
7.	Characteristics of solar PV.
8.	Testing of solar PV modules.
9.	Testing of battery.
10.	Characteristics of Wind Energy System.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	MATLAB

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	compute the time current characteristics of analog/digital/numerical relays	Applying (K3), Manipulation (S2)
CO2	understand and analyze the VI characteristics of renewable sources and power quality indices	Applying (K3), Manipulation (S2)
CO3	analyze the testing of solar PV modules and batteries	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20EEL62 MICROPROCESSOR AND MICROCONTROLLER LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	PC	0	0	2	1

List of Exercises / Experiments :

1.	Arithmetic operations using 8085 Microprocessor.
2.	Arithmetic operations using 8051 Microcontroller.
3.	Interfacing of switches and relays using Microcontroller 8051.
4.	Interfacing of LED and seven segment LED using Microcontroller 8051.
5.	Interfacing of Keypad and LCD using Microcontroller 8051.
6.	Generating Analog Wave form (Square) Using 8051 Microcontroller.
7.	Interfacing of DC Motor with 8051 Microcontroller system.
8.	Interfacing of Stepper motor with 8051 Microcontroller system.
9.	Case Study 1: Design and develop a simple project using Microcontroller 8051.
10.	Case Study 2: Design and develop a simple closed loop application using Microcontroller 8051.

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	Microcontroller Programming Software for 89c51 Microcontroller and Dumper kits.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the instructions in 8085	Applying (K3), Precision (S3)
CO2	design interfacing circuits with 8051 microcontroller	Applying (K3), Precision (S3)
CO3	develop microcontroller based systems for real time applications	Analyzing (K4), Precision (S3)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20EEL63 ELECTRIC DRIVES LABORATORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	PC	0	0	2	1

List of Exercises / Experiments:

1.	Simulation of closed loop control of converter fed DC motor drive.
2.	Simulation of closed loop control of chopper fed DC motor drive.
3.	Simulation of VSI fed Three phase induction motor drive.
4.	Simulation of Three phase synchronous motor drive.
5.	Speed control of DC motor drive using Three phase Rectifier.
6.	Speed control of Three phase induction motor drive using PWM inverter.
7.	FPGA based drive for induction motor.
8.	DSP based Speed control of BLDC motor drive.
9.	Speed control of SRM Drive in open and closed loop.
10.	DSP based chopper drive for DC Motor (Programming and Implementation).

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	MATLAB Software

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	examine the performance of DC and AC drives using software tool	Analyzing (K4), Manipulation (S2)
CO2	demonstrate the speed control of DC and AC motor using conventional techniques	Applying (K3), Manipulation (S2)
CO3	execute the modern digital control techniques for the speed control of DC motor, AC motor and special electrical machines.	Applying (K3), Manipulation (S2)

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20EEE01 POWER SEMICONDUCTOR DEVICES

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PE	3	0	0	3

Preamble	The objective of this course is to study and analyze the characteristics of power semiconductor devices. This course also provides working operation of various firing and protecting circuits and its signification.	
Unit - I	**Power Semiconductor Diodes**	**9**
Introduction – power diode characteristics – power diode types: General purpose diodes, fast recovery diodes and schottky diodes – performance parameters – Effects of forward and reverse recovery time – series connected diodes – parallel connected diodes – data sheet interpretation of power diodes.		
Unit - II	**Power Transistors**	**9**
Introduction – Bipolar junction transistor: performance parameters, based drive control – Power MOSFET: Performance parameters, Gate drive – series and parallel operation – di/dt and dv/dt limitation – Isolation of gate and base drives: pulse transformers and optocouplers – data sheet interpretation of power transistors.		
Unit - III	**Power Thyristors**	**9**
Introduction – two transistor model of thyristor – di/dt and dv/dt protection – Thyristor types: Phase control thyristors, fast switching thyristors, Gate turn Off thyristors, Bidirectional Triode Thyristors, Reverse conducting thyristors and light activated silicon controlled rectifiers – Performance parameters: SCR and GTO – series and parallel operation of thyristors – data sheet interpretation of power thyristor.		
Unit - IV	**Thyristors Firing and Commutation Techniques**	**9**
Thyristors firing circuits – natural commutation – forced commutation: self commutation, impulse commutation, resonance pulse commutation, complementary commutation, load side and line side commutation – commutation circuit design – commutation capacitors.		
Unit – V	**Protection of Power Electronics Devices and Circuits**	**9**
Introduction – cooling and heat sinks – snubber circuits – reverse recovery transients – supply and load side transients – voltage protection by selenium diodes and metal oxide varistors – current protections: fusing – fault current with AC source – fault current with DC source.		

Total:45

TEXT BOOK:

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", 4th Edition, Pearson Education., New Delhi, 2014.

REFERENCES:

1. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design”, 3rd Edition, John Wiley and sons, 2007
2. MD Singh and K.B Khanchandani, “Power Electronics”, 2nd Edition, McGraw Hill, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the basic principle and operation of Diode.	Understanding (K2)
CO2	explicate the basic principle and operation of transistor	Understanding (K2)
CO3	describe the principle and operation of power thyristors	Understanding (K2)
CO4	demonstrate the principle and operation of thyristor firing and commutation techniques	Applying (K3)
CO5	design and analyze firing and protection circuits.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1											3	2
CO2	2	1											1	2
CO3	3	2	1										2	2
CO4	3	2	1										2	2
CO5	3	3	1										2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE02 ELECTRICAL DISTRIBUTION SYSTEM ANALYSIS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Generation,Transmission and Distribution	5	PE	3	0	0	3

Preamble	This course is designed to provide knowledge about modeling of distribution system components and the analysis of the power flow in balanced and unbalanced distribution system	
Unit - I	**Introduction**	**9**
Distribution System – Distribution Feeder Electrical Characteristics – Nature of Loads: Individual Customer Load, Distribution Transformer Loading and Feeder Load – Approximate Method of Analysis: Voltage Drop, Line Impedance, “K” Factors, Uniformly Distributed Loads and Lumping Loads in Geometric Configurations.		
Unit - II	**Distribution System Line and Transformer Model**	**9**
Exact Line Segment Model – Modified Line Model – Approximate Line Segment Model – Three phase transformer model: Generalized matrices – Delta grounded Wye step down connection – Ungrounded Wye – Delta step down connection.		
Unit - III	**Load Model**	**9**
Wye-Connected and Delta-Connected Loads: Constant real and reactive power loads, constant impedance loads, constant current loads, combination loads – Two Phase and Single Phase Loads – Shunt Capacitors – Three phase induction motor		
Unit - IV	**Voltage Regulation**	**9**
Standard Voltage Ratings – Two-Winding Transformer Theory – Two-Winding Autotransformer – Step-Voltage Regulators: Single Phase Step-Voltage Regulators – Three Phase Step-Voltage Regulators.		
Unit - V	**Distribution Feeder Analysis**	**9**
Power Flow Analysis – Ladder Iterative Technique – Unbalanced Three-Phase Distribution Feeder – Modified Ladder Iterative Technique – Load Allocation – Short-Circuit Studies.		

Total:45

TEXT BOOK:

1. William H. Kersting," Distribution System Modeling and Analysis", 3rd Edition, CRC press, New York ,2012.

REFERENCES:

1. Turan Gonen, “Electric Power Distribution Engineering”, 3rd Edition, CRC Press, New York ,2014.
2. Pabla A S, “Electrical Power Distribution”, 7th Edition, McGraw-Hill, New Delhi, 2019

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the concepts of electrical distribution system.	Understanding (K2)
CO2	model the distribution lines and transformers	Understanding (K2)
CO3	model the various types of distribution loads.	Understanding (K2)
CO4	apply the concepts of voltage control in distribution system.	Applying (K3)
CO5	discuss the power flow techniques in balanced and unbalanced system	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											3	
CO2	3	1											3	
CO3	3	2											3	
CO4	3	2	1										3	
CO5	3	2	1										3	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE08 RENEWABLE ENERGY SYSTEM

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	PE	3	0	0	3

Preamble	This course confers the new methodologies and recent technologies for effective utilization of renewable energy sources and various nuances behind renewable energy conversion process.	
Unit - I	**Solar Energy**	**9**
Solar radiation at the earth's surface – Solar radiation measurements – Solar energy collectors: flat plate and concentrating collectors. Solar electric power generation: Solar Photo-Voltaics – Applications of solar energy: solar pumping and solar cooking.		
Unit - II	**Wind Energy**	**9**
Basic components of a wind energy conversion system – Classification. Wing Energy Collectors: horizontal axis and vertical axis machines – Performance of wind machines – Generating system – Energy storage – Applications of wind Energy – Interconnected systems – Safety systems – Environmental aspects.		
Unit - III	**Bioenergy, Geothermal Energy and Ocean Energy**	**9**
Bioenergy: Biomass conversion technologies – Biogas generation – Classification of biogas plants – Ethanol production. **Geothermal Energy:** Geothermal sources – Prime movers for geothermal energy conversion. **Ocean Energy:** Basic principle of tidal power – Components – Operation methods, Ocean waves **–** Energy and power from waves – wind energy conversion devices.		
Unit - IV	**Additional Alternate Energy Sources and Chemical Energy Sources**	**9**
MHD power generation – Thermoelectric power generation. Chemical energy sources: Hydrogen production – Storage – Transportation and utilization – Hydrogen as an alternative fuel for motor vehicles – Fuel cell – Principle – Types.		
Unit - V	**Energy Conservation**	**9**
Principles of energy conservation – Energy conservation approach/ technologies – Co-generation – Waste heat utilization – Combined cycle power generation – Heat regenerators – Heat pipes – Heat pumps.		

Total: 45

TEXT BOOK:

1. Rai G.D., "Non-Conventional Energy Sources", 6th Edition, Khanna Publishers, New Delhi, 2017.

REFERENCES:

1. Kothari D.P, Singal K.C & Rakesh Ranjan. "Renewable Energy Sources and Emerging Technologies", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2011.
2. John Twidell & Tony Weir. "Renewable Energy Resources", 3rd Edition, Routledge, New York, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the working and applications of solar energy systems	Understanding (K2)
CO2	explain the working and applications of wind energy systems	Understanding (K2)
CO3	express the principle of the bio-energy production techniques and operation of geothermal energy and ocean energy sources	Understanding (K2)
CO4	explain the operation of additional alternate energy sources	Understanding (K2)
CO5	describe the principle of energy conservation and its technologies	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2				1						2	3
CO2	3	2	2				1						2	3
CO3	3	2	2				1						2	3
CO4	3	2	2				1						3	2
CO5	3	2	3				1						3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60					100
CAT2	40	60					100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE04 Generalized Machine Theory

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	DC Machines and Transformers, Synchronous and Induction Machines	5	PE	3	0	0	3

Preamble	The objective of the course is to derive, model and analysis of various DC, AC and permanent magnet machines. Apply various transformation techniques and reference frame theories to simplify the machine dynamic models.	
Unit - I	**Generalized Machine Theory**	**9**
Essential of Rotating Electrical Machines – Conventions – The Basic Two Pole Machine – Invariance of Power – MMF Distribution of DC and AC Machines – Transformations from Three Phase to Two Phase – Kron's Primitive Machine – Restriction of the Generalized Theory of Electrical Machines – Applications.		
Unit - II	**Modeling of DC Machines**	**9**
Theory of Operation – Induced EMF – Equivalent Circuit – Electromagnetic Torque – Field Excitation- Steady State and Transient Analysis of DC Machine – Separately Excited Motor – Shunt Motor – Series Motor – Compound Motor.		
Unit - III	**Modeling of Reluctance and Permanent Magnet Machines**	**9**
Synchronous Reluctance Motor – Voltage Equation of Single Phase and Three Phase Synchronous Reluctance Motor – Permanent Magnet Synchronous Motor (PMSM) – PMSM Voltage Equation in Machine Variables – Permanent Magnet DC Motor – Modeling of Permanent Magnet DC Motor.		
Unit - IV	**Modeling of Induction Machines**	**9**
Three Phase Induction Motor – Voltage and Torque Equation in Machine Variables – Reference Frame Theory – Voltage and Torque Equation in Arbitrary Reference Frame – Voltage and Torque Equation in Synchronous Reference Frame – Model Parameter Identification – Steady State and Transient Analysis of Three Phase Induction Motor.		
Unit - V	**Modeling of Synchronous Machines**	**9**
Three Phase Synchronous Motor – Voltage and Torque Equations in Machine Variables – Voltage Equation in Rotor Reference Frame – Model Parameter Identification – Steady State and Transient Analysis of Three Phase Synchronous Motor.		

Total:45

TEXT BOOK:

1. Bimbhra P.S, "Generalized Theory of Electrical Machines", 6th Edition,Khanna Publishers, 2018 for Unit I,II.
2. Paul C Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3rd Edition, IEEE Press Series on Power and Energy Systems, 2013 for Unit III,IV,V.

REFERENCES:

1. Charles Kingsley Jr., A.E. Fitzgerald & Stephen D.Umans, "Electric Machinery", New York, McGraw-Hill Higher Education, 2017.
2. Slobodan N. Vukosavic, "Electrical Machines", 1st Edition, Springer-Verlag New York, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the fundamentals of mathematical modeling and transformation techniques	Understanding (K2)
CO2	derive the non-linear mathematical equation and analysis the dc shunt, series and compound motors	Applying (K3)
CO3	derive the mathematical equation for reluctance and permanent magnet motor	Applying (K3)
CO4	apply various reference frame theories and transformation techniques to three phase induction motor	Applying (K3)
CO5	derive the non-linear mathematical equations for three phase synchronous motor	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											3	1
CO2	3	2	1										2	3
CO3	3	2	1										2	3
CO4	3	2	1										1	3
CO5	3	2	1										2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE05 DIGITAL SYSTEM DESIGN

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Digital Electronics	5	PE	3	0	0	3

Preamble	This course imparts knowledge on different PLD's, analyzing different State Machine charts and Designing FPGAs with its implementation using Verilog code for different combinational and sequential circuits.	
Unit - I	**Programmable Devices**	**9**
Simple Programmable Logic Devices – Complex Programmable logic devices – Field Programmable gate arrays – Implementing functions in FPGA.		
Unit - II	**State Machine Charts**	**9**
State Machine Chart – Derivation of State Machine chart – Realization of State Machine chart – implementation of the dice game.		
Unit - III	**Designing with FPGA's**	**9**
Implementing Functions in FPGAs – Implementing Functions Using Shannon's Decomposition – Carry and Cascade Chains in FPGAs – Examples of Logic Blocks in Commercial FPGAs – Dedicated Memory in FPGAs – Dedicated Multipliers in FPGAs – Design Translation (Synthesis) – Mapping, placement, and Routing		
Unit - IV	**Additional Topics in Verilog**	**9**
Verilog Functions – Verilog Tasks – Multivalued Logic and Signal Resolution – Built-in Primitives – User-Defined Primitives – SRAM Model – Rise and Fall Delays of Gates – Named Association – System Functions – Compiler Directives – File I/O Functions – Timing Checks		
Unit - V	**Design Examples using Verilog**	**9**
BCD to 7-Segment Display Decoder – A BCD Adder – 32-Bit Adders –Traffic Light Controller – State Graphs for Control Circuits – Scoreboard and controller – A Shift-and-Add Multiplier – Array Multiplier – A Signed Integer/Fraction Multiplier		

Total:45

TEXT BOOK:

1. Charles H. Roth Jr, Lizy Kurian Johnb & Byeong Kil Lee, "Digital Systems Design Using Verilog ", 1st Edition, Cengage learning publication, New Delhi, 2016.

REFERENCES:

1. Taraate Vaibbhav, "Digital Logic Design Using Verilog Coding and RTL Synthesis", 1st Edition, Springer India, 2016.
2. Zainalabedin Navabi, "Verilog Digital System Design ", 2nd Edition, McGraw Hill Education, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	compare programmable logic devices and implement various logic functions using PLDs.	Understanding (K2)
CO2	design and analyze algorithmic state machine for logic circuit.	Analyzing (K4)
CO3	designing and implementing various functions using FPGA's	Applying (K3)
CO4	develop Verilog code for any combinational and sequential logic circuits.	Applying (K3)
CO5	analyze, design and develop Verilog Code for some specific examples	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	2	2	1								2	3
CO2	3	2	1	1									2	3
CO3	3	2	1	1									1	2
CO4	3	1											1	2
CO5	3	1											1	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	40	20			100
CAT2	10	10	60	10			100
CAT3	10	30	40	20			100
ESE	10	30	30	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Power Electronics	6	PE	3	0	0	3

Preamble	This course is designed to impart knowledge about the configuration, control strategies and back to back converter for power electronics circuits.	
Unit - I	**Configuration of Power Electronics Circuit**	**9**
Neutral point clamped configuration: Three level and Five level configurations – cascade configuration: single and two H bridge converter – PWM Implementation of single and two H bridge converter – flying capacitor configuration: three phase FC converter .		
Unit - II	**Optimized PWM approach**	**9**
Introduction – two leg and three leg converter: Model, PWM implementation, Analog and digital implementation – space vector modulation – other configuration with CPWM: three leg and four converter – Nonconventional topologies with CPWM: Z-Source converter.		
Unit - III	**Control strategies for Power Converters**	**9**
Introduction – basic control principles – hysteresis control – linear control with DC variable: P, PI and PID controller for RL load – linear control with ac variable – cascade control strategies: rectifier circuit for voltage and current control.		
Unit - IV	**Single Phase to Single Phase Back to Back Converters**	**9**
Introduction – Full Bridge converter: Model, PWM strategy, control approach – topology with component count reduction: Model – PWM strategies – Topologies with increased number of switches: converter in series and parallel.		
Unit - V	**Design of converter**	**9**
Introduction – Switched Mode DC-to-DC Converter – Design constraints of reactive elements: Design of inductor, transformer and capacitors, Input filter requirement – boundary between continuous and discontinuous conduction – critical values of inductance/load resistance.		

Total: 45

TEXT BOOK:

1.	Euzeli dos Santos, Edison R. da Silva, “Advanced Power Electronics Converters”, New Edition, John Wiley and sons, 2014 for units I,II,III,IV

REFERENCES:

1.	Rashid M.H., “Power Electronics Circuits, Devices and Applications ", 4th Edition, Pearson Education., New Delhi, 2014.
2.	Ned Mohan, Tore M. Undeland & William P.Robbins, “Power Electronics: converters, Application and Design”, 3rd Edition, John Wiley and sons, 2007

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	appraise different configuration of power electronics circuit	Understanding (K2)
CO2	analyze the various PWM topologies for power converters	Understanding (K2)
CO3	examine the Control strategies of power converters	Understanding (K2)
CO4	design and analyze of single phase to single phase back to back converter	Applying (K3)
CO5	design and analyze of switched mode converters	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1											3	1
CO2	2	1											1	2
CO3	3	2	1										2	1
CO4	3	2	1										2	2
CO5	3	3	1										2	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

20EEE07 SUBSTATION ENGINEERING AND AUTOMATION

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Generation, Transmission & Distribution	6	PE	3	0	0	3

Preamble	The course aims in imparting knowledge of substation and its components	
Unit - I	**Introduction**	**9**
General background – Functions of a Substation – Substation Layouts, Busbar Schemes – Voltage levels in AC and HVDC substations – Types of Substations – Features of a substation – Substation equipment – Grounding system – Insulation co-ordination and Surge Arresters – Protective Systems		
Unit - II	**Equipments and Earthing**	**9**
Busbars – Circuit Breakers – Isolators and Earthing switches – Power transformers – CT & VT's – Surge Arresters – Classification of substations – Functional requirements and Description of Earthing system – Equipment Earthing – Neutral point Earthing – Dimension of Earth Conductors – Earth mat – Measurement of Earth Resistance		
Unit - III	**Gas Insulated Substations and Cables**	**9**
Introduction – Applications – Application and range of ratings – Demerits of GIS –Configuration of GIS – Circuit arrangements and Single Line Diagram of GIS – Design aspects – Earthing Switches in GIS – CGIC & CGIT for EHV and UHV Power Transmission – Hybrid Substations		
Unit - IV	**Protection, Control and Automation in Substations**	**9**
Control room and panels – Protective relaying in Substations – Power transformer protection – Bus Zone protection – Protection of Transmission Lines – Carrier assisted distance protection – Substation Control – Applications of digital computers in Substation control – Microprocessor based Relays – Power theft control and Smart metering		
Unit - V	**Maintenance of EHV-AC and HVDC Substations**	**9**
Introduction terminologies – Maintenance of Power transformer, Switchgear and Circuit Breakers – Dielectric oil – Insulation Resistance measurement – Drying out of Power transformer – Preventive Maintenance of HVDC Substation – Hot Line Maintenance		

Total:45

TEXT BOOK:

1. Rao S, "Electrical Substation Engineering and Practice EHV-AC, HVDC and SF6 – GIS", Khanna Publishers, 3rd Edition, 2015

REFERENCES:

1. John D. McDonald, "Electric Power Substations Engineering ", CRC Press 3rd edition, 2017
2. James A. Momoh, "Electric Power Distribution, Automation, Protection, and Control", CRC Press,Taylor and Francis Group, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	review the basics of substations and its components	Understanding (K2)
CO2	discuss the different substation equipments and earthing	Understanding (K2)
CO3	infer Gas Insulated Substations and Cables	Understanding (K2)
CO4	develop the different controls and Automation in substations	Applying (K3)
CO5	describe about the maintenance of substations	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1	1	1								3	2
CO5	3	2	1										3	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	20	80					100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE03 BIOMASS ENERGY SYSTEM

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Materials Science and Solid State Devices	**5**	**PE**	**3**	**0**	**0**	**3**

Preamble	Biomass energy has evolved through chemical, biological and thermal conversion process. The requirement of learning the nuances of biomass has become significantly important and in fact, this subject addresses the need of biomass, biogas and bio diesel in a comprehensive manner.	
Unit - I	**Introduction**	**9**
Biomass energy usage – Overall energy needs – Sources of biomass available – Units and conversions – Problems and issues – Advantages and disadvantages in use of biomass as energy source.		
Unit - II	**Biomass Conversion process**	**9**
Overview – Chemical and biological conversion processes – Thermal conversion process – Hybrid conversion process – Application of biomass conversion products.		
Unit - III	**Biogas Production**	**9**
Introduction – Biomass parameters in anaerobic digestion – Advantages and disadvantages of anaerobic digestion process – Biogas conversion process and digester designs – Design of biogas digester – Biogas utilization.		
Unit - IV	**Bio-Diesel Production**	**9**
Introduction – Vegetable oil and animal fat characteristics – Fatty acid composition – Basic oil properties – Oil Extraction processes – Oil refining process – Transesterification - Engine performance and exhaust emissions.		
Unit - V	**Biomass Combustion**	**9**
Introduction – Types of biomass combustion systems – Co-combustion of biomass and co-firing with coal – Slagging and fouling issues with agricultural biomass – Determining melting point of biomass ash pellets – Applications of biomass combustion systems.		

Total: 45

TEXT BOOK:

1. Sergio Capareda., "Introduction to Biomass Energy Conversions", 1st Edition, CRC press, India, 2013.

REFERENCES:

1. Kothari D.P., Singal K.C., Rakesh Ranjan., "Renewable Energy Sources and Emerging Technologies", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2011.
2. John Twidell, Tony Weir., "Renewable Energy Resources", 3rd Edition, Routledge, New York, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the nature and principle of biomass energy extraction systems	Understanding (K2)
CO2	illustrate various biomass conversion process	Understanding (K2)
CO3	interpret biogas production and digester design	Applying (K3)
CO4	categorize various techniques for bio-diesel refining process	Applying (K3)
CO5	access different types of biomass combustion process	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2				2						3	2
CO2	2	3	2										3	2
CO3	2	2	3										2	3
CO4	2	2	3										2	3
CO5	2	2	3										2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE09 SPECIAL ELECTRICAL MACHINES

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	DC Machines and Transformers, Synchronous and Induction Machines	6	PE	3	0	0	3

Preamble	This course imparts knowledge about the construction and working principle of various special electrical machines and provide brief idea about their applications.	
Unit - I	**Permanent Magnet Synchronous Motors**	**9**
Permanent Magnet Motors – Classifications – PMSM: Constructional features - Principle of operation – EMF and torque equations– Phasor diagram – Locus diagram and torque speed characteristics – Closed loop control - Applications: PMSM for Railway vehicles.		
Unit – II	**Permanent magnet brushless D.C. Motors**	**9**
Principle of operation – Types – Comparison between conventional DC and PMBLDC – Electronic commutation – EMF and torque equations – Sensors for Rotor position – Closed loop control – Motor characteristics and control – Applications: PMBLDC for Plug in Electric Vehicles.		
Unit – III	**Synchronous Reluctance Motors**	**9**
Constructional features – Synchrel – Types: Axial and Radial motors – Operating principle – Reluctance torque – Phasor diagram - Characteristics – control of synchrel motor – Applications: SyRM for Electric ships – Introduction to Vernier motor – Permanent Magnet vernier motor.		
Unit – IV	**Switched Reluctance Motors**	**9**
Constructional features – Principle of operation – Torque prediction – Inductance profile –Types of Power controllers and converter topologies used – Current control schemes – Torque Speed Characteristics – Hysteresis and PWM control – Closed loop control – Applications: SRM for Hybrid electric vehicles.		
Unit – V	**Stepping Motors**	**9**
Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Theory of torque predictions – Linear and non-linear analysis – Characteristics – Drive circuits – Applications: Stepper Motor for Computer printers – Microprocessor based control.		

Total:45

TEXT BOOK:

1. Janardanan E.G, "Special Electrical Machines", 1st Edition, PHI Learning Private Ltd, New Delhi, 2014.

REFERENCES:

1. Kenjo T, "Stepping Motors and Their Microprocessor Controls", 3rd Edition, Oxford University Press, New Delhi, 2009.
2. Miller T.J.E, "Brushless Permanent Magnet and Reluctance Motor Drives", 1st Edition, Clarendon Press, United States, 1989.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the construction, operation and performance of permanent Magnet synchronous motor.	Understanding (K2)
CO2	identify and distinguish the conventional DC and PMBLDC motors based on its performance	Applying (K3)
CO3	distinguish Synchrel and switched reluctance motors based on its performance	Applying (K3)
CO4	demonstrate the performance of stepper motor and characterize its curves	Applying (K3)
CO5	choose special drives for specific applications	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											1	2
CO2	3	2	1	1									2	3
CO3	3	2	1	1									2	3
CO4	3	2	1	1									2	3
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20				100
CAT2	30	50	20				100
CAT3	30	50	20				100
ESE	30	50	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE10 VLSI DESIGN

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Digital Electronics	6	PE	3	0	0	3

Preamble	To expose the knowledge of VLSI System Design in terms of modelling of MOS transistors, designing CMOS logic circuits with its fabrication techniques and programming various digital logic circuits using Verilog Hardware Description Language in different modeling	
Unit - I	**Introduction**	**9**
CMOS Logic – CMOS Fabrication and Layout – Physical Design – Design Verification – Fabrication, packaging and Testing		
Unit - II	**MOS Transistor Theory**	**9**
Introduction – MOS transistor operating regions – Long Channel VI characteristics – Non ideal I-V effects – DC transfer characteristics		
Unit - III	**CMOS Processing Technology & Circuit Design**	**9**
Introduction – CMOS technologies – Layout Design Rules – CMOS Process Enhancement – Combinational Circuit Design: Circuit Families – Sequential Circuit Design: Circuit Design for Latches and Flipflops		
Unit - IV	**VERILOG HDL–I**	**9**
VLSI Design Flow – Dataflow modelling – Continuous Assignments – Delays – Expressions, operators, operands – Operator Types – Dataflow modelling Examples – Behavioural modelling – Structured Procedures – Procedural Assignments – Timing controls – Conditional statements – Multiway branching -Loops – Behavioural modelling Examples		
Unit - V	**VERILOG HDL–II**	**9**
Tasks and Functions – Difference between tasks and functions – Tasks – Functions – Useful Modelling Techniques – Switch level modelling Elements – Switch level modelling Examples		

Total:45

TEXT BOOK:

1.	Neil H. E. Weste & David Money Harris, “CMOS VLSI Design A Circuits and Systems Perspective”, 4th Edition, Pearson Education, New Delhi, 2017 for Unit I,II,III
2.	Samir Palnitkar, “Verilog HDL: Guide to Digital Design and Synthesis”, 2nd Edition, Pearson Education, New Delhi, 2017 for Unit IV,V

REFERENCES:

1	Pucknell, Douglas A & Eshragian, K., “Basic VLSI Design”, 3rd Edition, Prentice Hall India, Pvt Ltd, 2006.
2	A.Albert Raj & T.Latha, “VLSI Design”, Prentice Hall India Learning Private Limited, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	comprehend the principles of CMOS Logic and its physical design process.	Understanding (K2)
CO2	explain MOS transistor characteristics.	Understanding (K2)
CO3	describe CMOS fabrication techniques, layout design rules and different manufacturing issues	Understanding (K2)
CO4	apply Verilog HDL modeling for different digital logic circuits in dataflow modelling and behavioural modelling.	Applying (K3)
CO5	model different digital logic circuits using Verilog HDL in Switch level modeling.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1											1	2
CO2	2	1											3	1
CO3	3	2	1	1									3	1
CO4	3	2	1	1									3	3
CO5	3	2	1	1									3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**70**	**10**				**100**
CAT2	**10**	**60**	**30**				**100**
CAT3	**10**	**30**	**60**				**100**
ESE	**20**	**40**	**40**				**100**

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

20EEE11 ADVANCED CONTROL THEORY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Control Systems	6	PE	3	0	0	3

Preamble	The objective of this course is to provides the concepts of the state space analysis, feedback control and stability analysis in discrete control systems.	
Unit - I	**Introduction to Design**	**9**
The design problem – Preliminary consideration of classical design – realization of basic compensator – cascade compensation in time domain and frequency domain – turning off PID controllers – feedback compensation.		
Unit - II	**Discrete Time Systems**	**9**
Mathematical Representation of the Sampling Process – signal reconstruction, Z-transform analysis of sampled data control system – Inverse Z transform – Z and S domain Relationship – closed loop pulse transfer function – Modified Z Transforms		
Unit - III	**Liapunov's Stability Analysis**	**9**
Introduction – Liapunov's stability criterion – direct method of Liapunov and linear system – methods of constructing liapunov functions for non linear system.		
Unit - IV	**Digital Control System Design**	**9**
z-Domain root locus – z-Domain digital control system design – Digital implementation of analog controller design – Direct z-domain digital controller design – Frequency response design – Direct control design – Finite settling time design.		
Unit - V	**Optimal Control System**	**9**
Parameter optimization: servomechanism – optimal control problems: transfer function approach, state variable approach – the state regulator problem – the infinite time regulator problem – the output regulator under tracking problem.		

Total:45

TEXT BOOK:

1. Nagrath I.J., Gopal M., "Control Systems Engineering", 6th Edition, New Age International Pvt. Ltd., New Delhi, 2017.

REFERENCES:

1. M. Sami Fadali,. Antonio Visioli, "Digital Control Engineering Analysis and Design" 2nd Edition, Academic Press, Singapore, 2012.
2. Norman S. Nise, "Control Systems Engineering", 8th Edition, Wiley-India Publishers, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	construct the basic control system model	Applying (K3)
CO2	express the behavior of discrete time system	Understanding (K2)
CO3	inspect the stability of discrete system	Applying (K3)
CO4	analyze digital control system	Applying (K3)
CO5	manipulate the optimal control system	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	2
CO2	2	3	2										3	2
CO3	2	3	2	1									2	3
CO4	3	2	2	2									3	2
CO5	2	3	2	1									3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	30	30				100
CAT2	30	40	30				100
CAT3	30	40	30				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE12 DESIGN OF POWER CONVERTERS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Power Electronics	7	PE	3	0	0	3

Preamble	This course is designed to impart knowledge about the characteristics of selection of power semiconductor devices, working principle, design calculation and implementation challenges in the field of power electronic converters.	
Unit - I	**AC to DC Converter**	**9**
Introduction– Design calculation of: Half bridge controlled rectifier with R load– Full Bridge Controlled rectifier with RL load – analysis of CCM and DCM – surge protection circuit – load short protection circuit.		
Unit - II	**Isolated Converters**	**9**
Buck Converter: Duty cycle determination – Open Loop CCM to DCM transition – calculation of critical inductance – Closed loop CCM & DCM – Output capacitor sizing – case study. Flyback converter: Open Loop CCM & DCM duty cycle determination – calculation of critical inductance – Peak voltage mode CCM & DCM in closed loop – Peak current mode CCM & DCM in closed loop – Output capacitor sizing – case study.		
Unit - III	**Non-Isolated Converters**	**9**
Boost Converter: Duty-Cycle Determination – Critical Inductance – Peak Current Mode Closed-Loop Steady State in CCM & DCM – DCM Output Capacitor Size – CCM Output Capacitor Size – Effects of Converter Non-idealities – Switch Utilization Factor – case study.		
Unit - IV	**DC to AC Converters**	**9**
Practical aspects in building three phase Inverter : design calculation – selection of power devices – protection circuits – system protection management – reduction of common mode EMI – thermal management – carrier based PWM implementation: gate driver faults – dead time control		
Unit - V	**Parallel and Interleaved Power Converters**	**9**
Comparison between High-Power Devices &Multiple Parallel Lower-Power Devices – Hardware Constraints in Paralleling IGBTs – Gate Control Designs for Equal Current Sharing – Advantages and Disadvantages of Paralleling Inverter – Interleaved Operation of Power Converters – Circulating Currents – Selection of the PWM Algorithm		

Total:45

TEXT BOOK:

1. Keng.C.Wu, “Switch Mode Power Converters”,1st Edition, Elsevier Academic Press, UK, 2006 for Units I,II,III.
2. Dorin O.Neacsu, “Power Switching Converters-Medium and High Power”, 1st Edition, CRC Press, USA, 2006 for Units IV,V.

REFERENCES:

1. Issa Batarseh & Ahmad Harb, “Power electronic circuit analysis and design”, 2nd Edition, Springer Publications, 2018

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design rectifier circuit with protection circuits.	Applying (K3)
CO2	design isolated converters with capacitor sizing in CCM & DCM operation	Applying (K3)
CO3	design non-isolated converters with capacitor sizing in CCM & DCM operation	Applying (K3)
CO4	analyze the practical aspects in inverter design	Understanding (K2)
CO5	understand the paralleling concepts of power converters.	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											3	2
CO2	3	2	1	1									2	3
CO3	2	1											2	3
CO4	3	2	1	1									1	2
CO5	2	1											2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		40	60				100
CAT2		40	60				100
CAT3		40	60				100
ESE		40	60				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE13 RESTRUCTURED POWER SYSTEM

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Generation, Transmission and Distribution, Power System Analysis	7	PE	3	0	0	3

Preamble	The objective of the course is to impart knowledge about the restructured power system, electric utility markets, pricing of transmission network and reforms in Indian power sector. The course will also bring out the differences between the conventional power system operation and the restructured power system.	
Unit - I	**OVERVIEW OF KEY ISSUES IN ELECTRIC UTILITIES RESTRUCTURING**	**9**
Introduction – Restructuring Models – Independent System Operator (ISO) – Power Exchange (PX) – Market Clearing Price (MCP) –Market Operations – Locational marginal price (LMP) – Market Power-Stranded Costs – Transmission Pricing – Congestion Pricing –Management of Inter-Zonal/Intrazonal Congestion		
Unit - II	**ELECTRIC UTILITY MARKETS AROUND THE WORLD**	**9**
California Markets – New York Market – PJM Interconnection – ERCOT ISO – New England ISO – Midwest ISO – Nord Pool (The Nordic Power Exchange) – Australia National Electricity Market – Restructuring In Canada – Electricity Industry in England and Wales		
Unit - III	**OASIS: OPEN ACCESS SAME-TIME INFORMATION SYSTEM**	**9**
Introduction – FERC Order – Structure of OASIS – Implementation of OASIS Phases – Posting of Information – Transfer Capability on OASIS –Transmission Services – Methodologies to Calculate ATC – Experiences with OASIS in Some Restructuring Models		
Unit - IV	**ELECTRICITY PRICING**	**9**
Introduction – Electricity price Volatility – Electricity Price Indices – Challenges to Electricity Pricing – Construction of forward pricing curves – Short term price forecasting Wheeling cost		
Unit - V	**ELECTRIC ENERGY TRADING**	**9**
Introduction – Essence of Electric Energy Trading – Energy Trading Framework: The Qualifying Factors – Derivative Instruments of Energy Trading – Portfolio Management – Energy Trading Hubs – Brokers in Electricity Trading – Green Power Trading.		

Total:45

TEXT BOOK:

1. Mohammad Shahidehpour & Muwaffaq Alomoush, "Restructured Electrical Power Systems: Operation, Trading and Volatility", 1st Edition, Taylor & Francis, New York, 2001.

REFERENCES:

1. Loi Lei Lai ,"Power System Restructuring and Deregulation", 1st Edition, John Wiley and Sons, New York, 2001.
2. Mohammad Shahidehpour, Hatim Yamin & Zuyi Li, "Market Operations in Electric Power Systems", 1st Edition, John Wiley and Sons, New York, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the key issues in electric utilities restructuring	Understanding (K2)
CO2	discuss the concept of electric utility markets in the united states & outside the united states	Understanding (K2)
CO3	discuss the concept of open access same-time information system	Applying (K3)
CO4	describe the concept of Electricity Pricing	Understanding (K2)
CO5	interpret and analyze the Electric Energy Trading	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											3	
CO2	3	2		1									3	
CO3	2	3	2	2									3	
CO4	2	3											3	
CO5	3	2											3	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	30	50	20				100
CAT3	30	70					100
ESE	30	50	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE14 DESIGN, INSTALLATION AND COMMISSIONING OF SOLAR AND WIND ENERGY SYSTEMS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	Design, installation and commissioning will always be a joyful content for the engineers as it incorporates the essence of real time study in lieu of theoretical concepts. This course aims in imparting the concepts and nuances of solar and wind energy conversion systems (WECS) along with its design, installation and troubleshooting procedures.	
Unit - I	**Components of solar PV systems**	**9**
Stand alone, grid connected and hybrid systems – Battery parameters – Battery selection – Charge controllers – DC-DC converters – Inverters – MPPT – Components of grid connected PV systems.		
Unit - II	**Solar PV system design**	**9**
Design methodology for solar PV system: Approximate design of solar PV system – Configuration of grid connected solar PV systems – Grid connected PV system design for power plants.		
Unit - III	**Installation and troubleshooting**	**9**
Installation and troubleshooting of standalone solar PV power plants – Safety in installation of PV systems – Installation and troubleshooting of solar PV power plants – Solar PV installation check list.		
Unit - IV	**Components for WECS**	**9**
Power output from an ideal turbine – Aerodynamics – Power output from practical turbines – Energy production and capacity factor – Methods of generating synchronous power – DC shunt generator with battery load – AC generators.		
Unit - V	**Design and Installation of WECS**	**9**
Site preparation – Electrical network – Selection of low voltage and distribution voltage equipments – Losses – Wind farm costs.		

Total: 45

TEXT BOOK:

1. Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems – A Manual for Technicians, Trainees and Engineers", 1st Edition, PHI learning Private Limited, New Delhi, 2013 for Units I,II,III.
2. Gary L.Johnson, "Wind Energy Systems", Electronic Edition, Manhatan, KS, 2006 for Units IV,V.

REFERENCES:

1. Chetan Singh Solanki, "Solar Photovoltaics – Fundamentals, Technologies and Applications", 2nd Edition, PHI learning Private Limited, New Delhi, 2011.
2. Spera, D.A., "Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering", 2nd Edition, ASME, New York, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the components involved in the solar PV energy conversion system	Understanding (K2)
CO2	apply the design procedures for solar PV systems towards installation	Applying (K3)
CO3	apply the installation and troubleshooting procedures in a solar PV system	Applying (K3)
CO4	identify the components required for wind energy conversion system	Understanding (K2)
CO5	examine the design and installation procedures for WECS	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3				1						2	3
CO2	2	3	2				1						2	3
CO3	2	3	2				1						3	2
CO4	2	2	3				1						2	3
CO5	2	3	2				1						3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE15 ADVANCED ELECTRIC DRIVES AND CONTROL

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Control systems, Microprocessor and Microcontroller, Electric Drives and Control	7	PE	3	0	0	3

Preamble	Advanced control techniques are applied to optimize the performance of electric drives	
Unit - I	**Control of Electrical Drives**	**9**
Modes of operation – speed control and drive types – closed loop control drive – current limit control – Closed loop torque control and speed control – Closed loop speed control of multi motor drives – Speed sensing – Current sensing – Phase-locked-loop (PLL) control – Closed-loop position control.		
Unit - II	**Control Techniques for Electrical Drives**	**9**
Basic Features of an Electric Drive – Block Diagram Representation of Drive Systems – Transfer Functions of armature and field control DC motor – Transient Response of Closed Loop Drive Systems – Frequency Response Approach – Stability of Controlled Drives – Performance indices of control system and Compensation.		
Unit - III	**Microprocessors Based Control Techniques**	**9**
Dedicated Hardware Systems versus Microprocessor Control – Application Areas and Functions of Microprocessors in Drive Technology – Control of Electric Drives Using Microprocessors for induction motor and DC motor.		
Unit - IV	**Traction Drives**	**9**
Electric Traction Services – Electric trains – Nature of Traction Load – Main Line and Suburban Train Configurations – Calculations of Traction Drive Rating and Energy Consumption – Important Features of Traction Drives – Traction Motors – Conventional DC and AC Traction drives – Diesel Electric.		
Unit - V	**Energy Conservation in Electrical Drives**	**9**
Measures for Energy Conservation in Electrical Drives – Use of Efficient Semiconductor Converters – Use of Efficient motors – Use of Variable Speed Drives – Energy Efficient Operation of Drives – Improvement of Power Factor – Electrical Drive Systems and Components		

Total: 45

TEXT BOOK:

1. Dubey G.K, "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2019 for Units I, IV, V.
2. Vedam Subrahmanyam, "Electric Drives: Concepts and Applications", 2nd Edition, McGraw-Hill, New Delhi, 2010 for Units II, III.

REFERENCES:

1. Krishnan.R., Electric Motor Drives: Modeling, Analysis & Control, 1st Edition, PHI Pvt. Ltd, New Delhi, 2001.
2. Bose B.K, "Power Electronics and Variable Frequency Drives: Technology and Applications", 1st Edition, Wiley India Pvt. Ltd., New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the control requirement of open and closed loop electric drives	Understanding (K2)
CO2	make use of control system concepts for drives control techniques	Applying (K3)
CO3	formulating the control stages for microprocessor orient control methods	Understanding (K2)
CO4	explain the control of Traction Drives	Applying (K3)
CO5	understand energy consumption at all stages of electric drives	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1										2	3
CO2	3	2	1										2	3
CO3	3	3	1										3	2
CO4	3	2	1	1									2	3
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	50	40				100
CAT2	10	60	30				100
CAT3	10	60	30				100
ESE	10	60	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks**

20EEE16 ADVANCED MICROPROCESSORS AND MICROCONTROLLERS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Microprocessor and Microcontroller	7	PE	3	0	0	3

Preamble	This Course explores the knowledge about advanced microprocessor and microcontroller	
Unit - I	**80186, 80286, 80386 and 80486 Microprocessors**	**9**
80186 Architecture – Enhancements of 80186 – 80286 Architecture – Real and Virtual Addressing Modes – 80386 Architecture –Special Registers – Memory Management – Memory Paging Mechanism – 80486 Architecture (718) – Enhancements – Cache Memory Techniques – Exception Handling – Comparison of Microprocessors (8086 – 80186 – 80286 – 80386 – 80486) – Applications and Datasheets		
Unit - II	**Pentium Microprocessors**	**9**
Pentium Microprocessor Architecture – Special Pentium Registers – Pentium Memory Management – New Pentium Instructions –Pentium Pro Microprocessor Architecture – Special features – Pentium II,III and IV Microprocessor Architecture – Comparison of Pentium Processors – Applications & Datasheets		
Unit - III	**ARM Processor and Programming**	**9**
General concepts – ARM7 – Instruction Set Architecture, Levels in architecture, Functional description – processor and memory organization – Introduction to RISC architecture, pipelining, Instruction issue and execution – Instruction formats – Addressing modes – Data alignment and byte ordering – Simple programs using Assembly language Instruction sets.		
Unit - IV	**MSP430 Microcontroller**	**9**
TI – MSP430 microcontroller feature – development environment – architecture – addressing modes – instruction set – clock and resets – functions – ISR – low power mode – sample programs in MSP430G2ET Launchpad		
Unit - V	**MSP430 Microcontroller Peripherals**	**9**
Digital I/O's – Timers – Analog I/O's – Communication: SPI – SPI with USI – SPI with USCI – I2C Master/Slave – UART – sample programs in MSP430G2ET Launchpad		

Total:45

TEXT BOOK:

1. Brey B.B, "The Intel Microprocessor 8086/8088 /80186/80188, 80286, 80386, 80486 PENTIUM, PENTIUM Pro, PII, PIII & IV Architecture, Programming & Interfacing", 8th Edition, Pearson Education, New Delhi, 2009 for Units I,II.
2. John Davies,"MSP430 Microcontroller Basics", 1st Edition, Newnes-Elsevier, 2008 for Units IV,V.

REFERENCES:

1. Larry D. Pyeatt, "Modern Assembly Language Programming with the ARM Processor", 1st Edition, Newnes-Elsevier, 2016
2. Jerry Luecke, "Analog and Digital Circuits for Electronic Control System Applications Using the TI MSP430 Microcontroller", 1st Edition, Newnes-Elsevier, 2005

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify the generalized architecture of various advanced microprocessors	Understanding (K2)
CO2	describe the architecture and functions of Pentium Microprocessors	Understanding (K2)
CO3	describe the architecture, Various operations and instruction set of ARM processor.	Analyzing (K3)
CO4	understand the concepts of development environment boards and operations	Understanding (K2)
CO5	apply the programming knowledge on development boards and its peripheral interfaces	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	3	2	2									3	3
CO4	3	2	1										2	2
CO5	3	3	2	2									3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	80					100
CAT2	10	70	20				100
CAT3	10	70	20				100
ESE	10	60	30				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

20EEE17 PLC AND SCADA SYSTEM

Programme & Branch	B.E.- Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	This course imparts knowledge about basic concepts of programmable logic controllers, programming languages, advanced PLC programming, process of SCADA system and also apply this knowledge to develop automation system in industrial applications.	
Unit - I	**Introduction to Programmable Logic Controller**	**9**
Overview of Programmable Logic Controller – Architecture – Principle of operation – I/O Modules: Discrete, Analog, Special – I/O Specifications – CPU – Memory design and types – Programming devices – Recording and Retrieving data – PLC programming languages. Introduction to Human Machine Interfaces (HMI).		
Unit - II	**Basic PLC Programming**	**9**
Fundamentals of Logic – Program Scan – Relay-Type Instructions – Instruction addressing – Branch and Internal relay instructions – Entering the Ladder diagram – Electromagnetic Control relays – Contactors – Motor Starters – Manual operated switches and Mechanically operated switches.		
Unit - III	**Advanced PLC Programming**	**9**
Programming Timers – Programming Counters – Math Instructions – Sequencer and Shift Register Instructions. PLC Applications: Bottle filling system – Traffic light control system		
Unit - IV	**SCADA**	**9**
Introduction to SCADA – A brief history of SCADA – Real-time systems – Remote control – Communications: communication system components – protocol-modems – Remote terminal units (RTUs) – Master terminal units (MTUs)		
Unit - V	**Applications of SCADA**	**9**
Applications: Real time Revisited – Accounting and grade of data – Scanning and communications – Automatic control. Applications –SCADA for Power Utility Network		

Total: 45

TEXT BOOK:

1. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, Tata McGraw-Hill , New Delhi, 2019 for Units I, II, III.
2. Stuart A. Boyer, “SCADA: Supervisory Control and Data Acquisition”, 4th Edition, ISA Press, USA, 2009 for Units IV, V.

REFERENCES:

1. Webb John W & Reis Ronald A, "Programmable Logic Controllers - Principles and Applications", 5th Edition, PHI Learning Private Limited, New Delhi, 2002.
2. Bolton W, “Programmable Logic Controllers”, 5th edition, ELSEVIER , New York, 2009

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the PLC hardware and programming languages for various applications	Understanding (K2)
CO2	develop PLC ladder logic programming for industrial problems	Applying (K3)
CO3	design a PLC system, component, or process to meet a set of specifications	Applying (K3)
CO4	impart the knowledge about SCADA and understand the components of SCADA	Understanding (K2)
CO5	apply PLC and SCADA in real time applications to meet industrial automation	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1									2	3
CO2	3	2	1	1									2	3
CO3	3	2	1	1									2	3
CO4	3	1											1	3
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20				100
CAT2	30	40	30				100
CAT3	30	50	20				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE18 PULSE GENERATING CIRCUITS FOR POWER CONVERTERS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Power Electronics	7	PE	3	0	0	3

Preamble	This course brings the fundamentals of pulse width modulation techniques and the various types. It is certainly needed for the development of pulses required for the power converters.	
Unit - I	**Fundamentals of PWM**	**9**
Fundamental Concepts of PWM – Evaluation of PWM Schemes – Double Fourier Integral Analysis of a Two-Level PWM waveform – Naturally Sampled PWM – PWM Analysis by Duty Cycle Variation – Regular Sampled PWM – Direct modulation.		
Unit – II	**Modulation of Single Phase VSI**	**9**
Topology of a Single Phase Inverter – Three level Modulation of a Single Phase Inverter – Analytic Calculation of Harmonic Losses – Sideband Modulation – Switched Pulse Position – Switched Pulse Sequence.		
Unit – III	**Modulation of Three Phase VSI**	**9**
Topology of a Three Phase VSI – Three Phase Modulation with Sinusoidal References – Third Harmonic Reference Injection – Analytic Calculation of Harmonic Losses – Discontinuous Modulation Strategies – Triplen Carrier Ratios and Sub harmonics.		
Unit - IV	**Space Vector Modulation Strategies**	**9**
Space Vector Modulation – Phase Leg References – Naturally Sampled SVM – Analytical Solution for SVM Harmonic Losses for SVM – Placement of the Zero Space Vector – Discontinuous Modulation – Phase Leg References for Discontinuous PWM – Analytical Solutions for Discontinuous PWM – Single Edge SVM		
Unit - V	**Programmed Modulation Strategies and Multilevel Converters**	**9**
Optimized spaced vector PWM – Harmonic elimination PWM – Performance index for optimality – optimum PWM – Minimum loss PWM – Multilevel converter alternatives – Harmonic Elimination applied to multilevel inverters – Minimum Harmonic distortion.		

Total: 45

TEXT BOOK:

1. Grahame Holmes.D & Thomas A. Lipo, “Pulse Width Modulation for Power Converters: Principles and Practice”, IEEE Press Series on Power Engineering, Wiley, 2003.

REFERENCES:

1. Mohammed H. Rashid, “Power Electronics: Circuits, Devices and Applications”, 4th Edition, Eastern Economy Edition, USA , 2004.
2. Dorin O. Neacsu, “Power-Switching Converters: Medium and High Power”, 2nd Edition, CRC Press, United States,2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the fundamental concepts of pulse width modulation techniques	Understanding (K2)
CO2	make use of inverter topologies in applying PWM techniques for single phase VSI	Understanding (K2)
CO3	make use of inverter topologies in applying PWM techniques for three phase VSI	Understanding (K2)
CO4	summarize the space vector modulation techniques and its advantages	Understanding (K2)
CO5	explain the strategies involved for harmonic elimination using PWM	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2										2	
CO2	3	2	2								1		1	
CO3	3	2	2								1		1	
CO4	3	2	2	1							1		1	
CO5	3	2	2	1							1		1	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	60	10				100
CAT2	30	70					100
CAT3	30	70					100
ESE	30	60	10				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE19 HIGH VOLTAGE ENGINEERING

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Electromagnetic Theory, Generation, Transmission and Distribution	7	PE	3	0	0	3

Preamble	The course is designed to understand various phenomena related to breakdown study and withstand characteristics of insulating materials. The course also describes the generation and measurement of DC, AC and Impulse voltages as well as various High voltage testing techniques.	
Unit - I	**Overvoltage Phenomenon in Power Systems**	**9**
Causes for over voltages – lightning phenomenon, lightning arrester – Over voltages due to switching surges, System faults and other abnormal conditions – Travelling waves on transmission lines (lines terminated with open end, short circuited end, apparatus).		
Unit - II	**Electrical Breakdown in Gases, Liquids and Solids**	**9**
Ionization processes – Townsend's Criterion – Paschen's law – Breakdown in non-uniform fields, corona discharge and its effects – Vacuum breakdown. Conduction and breakdown in pure and commercial liquids. Intrinsic breakdown in solids – Electromechanical breakdown – Thermal breakdown – Breakdown in composite dielectrics.		
Unit - III	**Generation of High Voltages and High Currents**	**9**
Generation of high DC voltages, alternating voltages, impulse voltages and impulse currents – Tripping and control of Impulse Generators.		
Unit - IV	**Measurement of High Voltage and High Currents**	**9**
High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers – Peak Voltmeter, Generating Voltmeters – Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps – High current shunts – Digital techniques in high voltage measurement.		
Unit - V	**High Voltage Testing of Electrical Power Apparatus**	**9**
Testing of Insulator, Bushings, Isolators, Transformers, and Surge Diverters – Advances in Partial Discharge measurement – Tan delta measurement, Radio interference measurement – International and Indian Standards.		

Total:45

TEXT BOOK:

1. Naidu M.S. & Kamaraju V, "High Voltage Engineering", 5th Edition, McGraw-Hill, New York, 2013.

REFERENCES:

1. Kuffel E, Zaengl W.S. & Kuffel J, "High Voltage Engineering Fundamentals", 2nd Edition, Butterworth-Heinemann, Burlington, 2005.
2. Wadhwa C.L, " High voltage Engineering", 3rd Edition, New Age Publishers, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the concepts of over voltage phenomenon	Understanding (K2)
CO2	discuss the conduction and breakdown in gases, liquids and solid dielectrics	Understanding (K2)
CO3	model the various generation circuits of high voltage and high currents.	Applying (K3)
CO4	identify the various measurement techniques of high voltage and high currents.	Understanding (K2)
CO5	explain the testing procedure of power apparatus	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											3	1
CO2	3	1											3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	1											3	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	30	70					100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE20 ENERGY STORAGE SYSTEMS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	This course aimed to introduce the fundamental concepts and principles of various energy storage systems that aids in various real time applications.	
Unit - I	**Energy Storage Systems**	**9**
Introduction – Battery – Components of Cells and Batteries – Classification – Operation of a Cell – Theoretical Cell Voltage, Capacity, and Energy. Electrochemical Principles and Reactions: Cell Polarization – Electrical Double-Layer Capacity and Ionic Adsorption – Mass Transport to the Electrode Surface.		
Unit - II	**Battery Design and Selection**	**9**
Designing to Eliminate Potential Safety Problems – Battery Safeguards when Using Discrete Batteries – Battery Construction – Factors Affecting Battery Performance – Major Considerations in Selecting a Battery – Applications of Batteries.		
Unit - III	**Primary & Secondary Batteries**	**9**
General characteristics and Applications of Primary batteries – Types and characteristics of Primary and Secondary batteries – Zinc –chloride Lithium Battery – Nickel Cadmium – Lead Acid – Nickel Hydride.		
Unit - IV	**Advanced Batteries for Emerging Applications**	**9**
Advanced Rechargeable Batteries – General Characteristics – Characteristics of lithium rechargeable batteries. Zinc/Air batteries – Zinc/bromine batteries – Lithium/Iron sulfide Batteries – General characteristics – Performance.		
Unit - V	**Fuel Cells & Ultracapacitors**	**9**
Fuel cells: General Characteristics – Operating Principles of Fuel Cells – Fuel processing and storage configurations. Electrochemical capacitors: Chemistry and material properties – Performance characteristics of devices.		

Lecture:45, Tutorial:0, Total:45

TEXT BOOK:

1. David Linden, Thomas B. Reddy, "Handbook of Batteries", 4th Edition, McGraw-Hill, New Delhi, 2011.

REFERENCES:

1. Mehrdad Ehsani, YiminGao, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicle", 2nd Edition, CRC Press, New Delhi, 2010.
2. James Larminie, Andrew Dick, "Fuel Cell System Explained", 2nd Edition, J. Wiley, New Jersy, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	evaluate the various aspects and performance of battery technologies	Understanding (K2)
CO2	understand the performance of primary batteries and their design aspects	Understanding (K2)
CO3	conceptualize the principles of Primary and Secondary batteries	Understanding (K2)
CO4	analyze the requirement of advanced batteries for emerging applications	Applying (K3)
CO5	illustrate the concepts & principles of fuel cells and ultra-capacitors	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1										3	2
CO2	3	2	2										3	2
CO3	2	1	3										3	2
CO4	3	2	1										2	3
CO5	2	1	3										3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	30	70					100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE21 CAD OF ELECTRICAL MACHINES

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	DC Machines and Transformers, Synchronous and Induction Machines	7	PE	3	0	0	3

Preamble	The objective of the course is to identify the design parameter for AC and DC electrical machines using various standard design procedures and development constrain. Apply finite element method and CAD package to design and analysis of electrical machines.	
Unit - I	**Fundamental Aspects and Materials**	**9**
Introduction – Design Factor – Limitations in Design – Windings of Electrical Machines: Salient Pole Winding, Lap and Wave Winding, Three Phase Winding - Electric Conductivity and Resistivity Material – Magnetic Material – Insulating Material – Permanent Magnet and Characteristics - Modern Manufacturing Practices		
Unit - II	**Principles of Magnetic and Thermal Design**	**9**
Fundamental of Magnetic Circuit – Magnetizing Curve – Real and Apparent Flux Density – Determination of Iron Loss – Determination of Copper Loss by Considering Skin and Proximity Effects – Modes of Heat Dissipation – Cooling Strategies		
Unit - III	**Design of DC Motor**	**9**
Constructional Details – Choice of Flux Density and Ampere Conductor – Main Dimension – Poles and Slots – Armature Windings – Design of Field and Armature System – Design of Commutator and Brushes		
Unit - IV	**Design of AC Motor**	**9**
Constructional Details: Induction Motor (IM), Synchronous Reluctance Motor (SYNRM) and Permanent Magnet Synchronous Motor (PMSM) – Choice of Flux Density and Ampere Conductor – Main Dimension – Three Phase Distributed Windings – Stator Design and Rotor Design: IM, SYNRM and PMSM – Length of Air Gap – Design of Shaft		
Unit - V	**Finite Element Modeling and Analysis using ANSYS Software**	**9**
Maxwell's Equation – Preprocessing – Meshing – Material Assigning – Boundary Conditions – Setting up Solution – Post processing – Design of DC Motor –Induction Motor – Permanent Magnet Synchronous Motor.		

Total:45

TEXT BOOK:

1. A.K.Sawhney, "Electrical Machine Design", 3rd Edition, Dhanpat Rai & Co, New Delhi, 2017.

REFERENCES:

1. Hendershot JR, Miller TJE, "Design of Brushless Permanent Magnet Motors", Motor design book LLC, Venice, 2010.
2. Juha Pyrhonen, Tapani Jokinen and Valeria Hrabovcova, "Design of Rotating Electrical Machines", 2nd Edition, John Wiley & Sons, New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify and compare the various fundamental aspects and materials used for AC and DC electrical machines	Understanding (K2)
CO2	illustrate the principles of magnetic and thermal design for various electrical machines	Understanding (K2)
CO3	identify the design parameter of DC motor by considering load requirement	Applying (K3)
CO4	identify the design parameter of AC motor by considering load requirement	Applying (K3)
CO5	design and finite element analysis of various electrical machines using software package	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2										3	1
CO2	3	2	2										3	1
CO3	3	2	1										2	3
CO4	3	2	1										2	3
CO5	2	3	2										2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	50	10				100
CAT2	30	40	30				100
CAT3	20	30	30	20			100
ESE	20	30	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE22 EMBEDDED SYSTEM AND IOT

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Microprocessor and Microcontroller	7	PE	3	0	0	3

Preamble	This course imparts knowledge about the Building Blocks of Embedded System along with various networking protocols and provides a brief idea of IoT architecture and its related protocols towards building an IoT infrastructure.	
Unit – I	**Introduction to Embedded Systems**	**9**
Introduction to Embedded Systems – Structural units in Embedded processor, selection of processor & memory devices – DMA – Memory management methods – Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.		
Unit – II	**Embedded Networking**	**9**
Embedded Networking: Introduction, I/O Device Ports & Buses – Serial Bus communication protocols RS232 standard – RS422 – RS 485 – CAN Bus – Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I^2C) – need for device drivers.		
Unit – III	**Fundamentals of IoT**	**9**
Evolution of Internet of Things – Enabling Technologies – IoT Architectures & its Security aspects: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects – Case study: Role of IoT in the implementation of Smart cities.		
Unit – IV	**IoT Protocols**	**9**
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.		
Unit – V	**Design and Development**	**9**
Design Methodology – Embedded computing logic – Microcontroller, System on Chips - IoT system building blocks – Arduino – Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi with Python Programming.		

Total: 45

TEXT BOOK:

1. Kamal R, “Embedded systems: architecture, programming and design”, 2nd Edition, Tata McGraw-Hill Education, New Delhi, 2011 for Units I, II.
2. Hanes D, Salgueiro G, Grossetete P, Barton R & Henry J, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things”, 1st Edition, Cisco Press, United States, 2017 for Units III,IV.

REFERENCES:

1. Hersent O, Boswarthick D & Elloumi O, “The Internet of Things – Key applications and Protocols”, 1st Edition, Wiley & Sons, United States, 2012.
2. Margolis M, Jepson B & Weldin N.R, “Arduino cookbook: recipes to begin, expand, and enhance your projects”, 3rd Edition, O'Reilly Media, United States, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the basic building blocks of embedded systems.	Understanding (K2)
CO2	identify and distinguish the various communication protocols of embedded system.	Applying (K3)
CO3	explain the concept of IoT and role of smart objects in IoT.	Understanding (K2)
CO4	select various protocols for establishing IoT infrastructure.	Applying (K3)
CO5	design and build an IoT system using Rasperry Pi/Arduino.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											1	2
CO2	3	2	1	1									2	3
CO3	3	1											1	2
CO4	3	2	1	1									2	3
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20				100
CAT2	30	50	20				100
CAT3	30	50	20				100
ESE	30	50	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE23 COMPUTATIONAL INTELLIGENCE TECHNIQUES

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	This course serves as a guide to explore computer methodology and algorithms that improves automatically through experience.	
Unit - I	**ARTIFICIAL NEURAL NETWORKS – I**	**9**
Introduction to Soft computing – Neural Networks – Model – activation functions – Linear separability. Supervised learning: Architecture and algorithm **-** Perceptrons – Adaline and Madaline – Back propagation algorithm – Radial Basis Function Networks.		
Unit - II	**ARTIFICIAL NEURAL NETWORKS-II**	**9**
Unsupervised Learning and Other Neural Networks – Competitive Learning Networks – Kohonen Self Organizing Networks – Learning Vector Quantization – Hebbian Learning – Deep neural networks – Applications: Neural network classifier.		
Unit - III	**FUZZY LOGIC**	**9**
Introduction to Fuzzy Logic - Classical Sets and Fuzzy Sets - Fuzzy Relations- Membership functions – Fuzzification – Defuzzification - Fuzzy if-then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models –Sugeno Fuzzy Models – Comparison between Mamdani and Sugeno method - Overview of Fuzzy Expert System.		
Unit - IV	**GENETIC ALGORITHM - I**	**9**
Simple genetic algorithm – Operators of Genetic Algorithm (GA): Encoding- selection – crossover – mutation. Stopping condition of GA – Problem solving using genetic algorithm – Schema theorem - Real coded genetic algorithm - Advantages and limitations – Applications of GA.		
Unit - V	**GENETIC ALGORITHM – II**	**9**
Advanced Operators and Techniques in Genetic Algorithm : Diploidy, Dominance and Abeyance – Multiploid - Inversion and Reordering - Parallel and Distributed Genetic Algorithm - Hybrid Genetic Algorithm (HGA) – Adaptive Genetic Algorithm – Fast Messy Genetic Algorithm - Independent Sampling Genetic Algorithm - Genetic Programming- Primitives-Attributes-Steps-Applications.		

Total:45

TEXT BOOK:

1. Sivanandam S.N.,Deepa S.N., “Principles of soft computing”, 2nd Edition, Wiley India Pvt Ltd,New Delhi,2018 for Unit I,II,III
2. Sivanandam S.N.,Deepa S.N., “Introduction to Genetic Algorithms”, Urheberrechtlich Geschutztes material, Springer-Verlag, Berlin Heidelberg,2008 for Unit IV,V.

REFERENCES:

1. Yegnanarayana, “Artificial Neural Networks”, Eastern economy, PHI learning Pvt Ltd, New Delhi, 2012.
2. Timothy J Ross, “Fuzzy Logic with engineering applications”, 4th Edition, John Wiley & Sons, UK, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	recognize neural networks to build intelligent systems.	Understanding (K2)
CO2	apply neural networks to solve classification and regression problems.	Applying (K3)
CO3	apply fuzzy principles to deal with vulnerability and tackle real time issues.	Applying (K3)
CO4	apply genetic algorithms to obtain optimized results for a particular problem.	Applying (K3)
CO5	apply advanced genetic operators and genetic programming to solve real world problems	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	2								2	3
CO2	3	2	1	1	2								3	2
CO3	3	2	1	1	2								3	2
CO4	3	2	1	1	2								2	3
CO5	3	2	1	1	2								3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	70	10				100
CAT2	10	70	20				100
CAT3	10	70	20				100
ESE	10	70	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE24 POWER ELECTRONIC INTERFACES TO RENEWABLE ENERGY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Power Electronics	7	PE	3	0	0	3

Preamble	This course aims to impart the students, in depth knowledge about the importance of power converters in renewable energy. The course covers design of solar photovoltaic, design of power converter for wind and hybrid system.	
Unit - I	**Photovoltaic Inverter Structures**	**9**
Introduction – Inverter Structures Derived from H-Bridge Topology – Inverter Structures Derived from NPC Topology – Typical PV Inverter Structures – Three-Phase PV Inverters – Control Structures.		
Unit - II	**Grid Synchronization in Single-Phase Power Converters**.	**9**
Introduction – Grid Synchronization Techniques for Single-Phase Systems – Phase Detection Based on In Quadrature Signals – PLLs Based on In – Quadrature Signal Generation – PLLs Based on Adaptive Filtering		
Unit - III	**Grid Converter Structures and requirements for Wind Turbine Systems**	**9**
Introduction – WTS Power Configurations – Grid Power Converter Topologies – WTS Control – Frequency and Voltage Deviation under Normal Operation – Active Power Control in Normal Operation – Reactive Power Control in Normal Operation		
Unit - IV	**Grid Synchronization in Three-Phase Power Converters**	**9**
Introduction – The Three Phase Voltage Vector under Grid Faults: Unbalanced Grid Voltages during a Grid Fault – The Synchronous Reference Frame PLL under Unbalanced and Distorted Grid Conditions – The Decoupled Double Synchronous Reference Frame PLL : The Double Synchronous Reference Frame – Relationship between the DSOGI and the DDSRF		
Unit - V	**Grid converter control for WTS**	**9**
Introduction – Model of the converter – AC voltage and DC voltage control – Voltage oriented control and direct power control – Stand-alone, Micro-grid, Droop Control and Grid Supporting.		

Total: 45

TEXT BOOK:

1. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, "Grid Converters For Photovoltaic and Wind Power Systems",1st Edition, Wiley, New Delhi, 2011.

REFERENCES:

1. Chetan Singh Solanki, "Solar Photovoltaics : Fundamentals, Technologies and Applications", 2nd Edition, PHI Learning Pvt. Ltd, New Delhi, 2011.
2. Mukund R Patel, "Wind and Solar Power Systems: Design, analysis and operation ", 2nd Edition, CRC Press, Boca Raton, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	recall various type of photovoltaic inverter structure	Understanding (K2)
CO2	explain the grid synchronization for single phase converter	Understanding (K2)
CO3	explain the grid synchronization in for three phase converter	Applying (K3)
CO4	interpret the grid converter structures and requirements for wind turbine systems	Applying (K3)
CO5	explain the grid converter control for wind turbine systems	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1											3	2
CO2	2	1											1	2
CO3	3	2	1										2	2
CO4	3	2	1										2	2
CO5	3	3	1										2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	70					100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

* ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)

20EEE25 POWER SYSTEM OPERATION AND CONTROL

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Generation Transmission and Distribution, Power system analysis	7	PE	3	0	0	3

Preamble	This course imparts knowledge about the operations of the power systems and various controls methods adapted in power systems. It also imparts the knowledge on computer control of power systems.	
Unit - I	**Introduction**	**9**
System load variation: System load characteristics, load curves:daily, weekly and annual, load-duration curve, load factor, diversity factor, Plant capacity factor, Utilization factor – Reserve requirements: spinning reserve, cold reserve and hot reserve – Need of voltage and frequency regulation – P-f and Q-V control – Load forecasting: purpose, classification and forecasting procedure.		
Unit - II	**Real Power Frequency Control**	**9**
Necessity of maintaining constant frequency – Load frequency control – Speed governing system – turbine model – generator model – concept of control area – Single area system static and dynamic analysis – Integral control – Two area system static and dynamic response – Area control error – Tie line frequency bias control		
Unit - III	**Reactive Power Voltage Control**	**9**
Necessity of voltage control – Generation and absorption of reactive power – Methods of voltage control: shunt capacitor, shunt reactor, series capacitor, tap-changing transformer, synchronous condenser and Static VAR compensators – Excitation control scheme – Types of excitation system: DC, AC and static excitation systems		
Unit - IV	**Power System Security and State Estimation**	**9**
Introduction – Concept of system security: long term planning, operational planning and on-line planning – Security analysis: and enhancement – State estimation – various operating states – Energy control centre and data acquisition.		
Unit - V	**Economic Dispatch**	**9**
Economic Dispatch Problem – Economic Dispatch with Piecewise Linear Cost Functions – LP Method: Piecewise Linear Cost Functions, Economic Dispatch with LP – The Lambda Iteration Method – Economic Dispatch Using Dynamic Programming – Composite Generation Production Cost Function – Base Point and Participation Factors **Unit Commitment:** Introduction – Need of unit commitment – Constraints in unit commitment: Spinning reserve, thermal unit constraint, hydro constraint, must run and fuel constraint – Solution methods: Priority list method, Full load average production cast, dynamic programming approach.		

Total:45

TEXT BOOK:

1. Sivanagaraju. S & Sreenivasan. G, " Power System Operation and Control ", 1st Edition, Pearson Education, New Delhi, 2009.

REFERENCES:

1. Allen J. Wood & Bruce F. Wollenberg, "Power System Operation and Control", 3rd Edition, John Wiley and Sons, New York, 2012.
2. Elgerd O.I, " Electrical Energy System Theory: An Introduction ", 2nd Edition, Tata McGraw-Hill, New York, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the overview of power system operation and control	Understanding (K2)
CO2	develop the transfer function model for the speed-governing system	Analyzing (K4)
CO3	analyze the static and dynamics performance of AVR loop	Analyzing (K4)
CO4	understand the concept of power system state estimation and security	Understanding (K2)
CO5	apply dynamic approaches for solving unit commitment and economic dispatch problems	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												1	3
CO2	2	3	2	2									2	3
CO3	2	3		2									2	3
CO4	3													3
CO5	3	2	1											3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	40	20			100
CAT2	20	30	40	10			100
CAT3	20	60	20				100
ESE	10	30	40	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE26 MICROGRID

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	The objective of this course is to impart knowledge about the renewable energy based microgrid technology, its types and issues associated with their practical realization. The course also elaborates the various protection, control and operational strategies intended for practical microgrid implementation.	
Unit - I	**The Microgrids Concept**	**9**
Introduction – The Microgrid Concept – Clarification of the Microgrid Concept – Operation and Control of Microgrids – Market Models for Microgrids – Status Quo and Outlook of Microgrid Applications.		
Unit - II	**Microgrids Control Issues**	**9**
Introduction – Control Functions – The Role of Information and Communication Technology – Microgrid Control Architecture –Centralized and Decentralized Control – Forecasting – Centralized Control – Decentralized Control – State Estimation.		
Unit - III	**Intelligent Local Controllers**	**9**
Introduction – Inverter Control Issues in the Formation of Microgrids – Control Strategies for Multiple Inverters – Implications of Line Parameters on Frequency and Voltage Droop Concepts – Development and Evaluation of Innovative Local Controls to Improve Stability.		
Unit - IV	**Microgrid Protection**	**9**
Introduction – Challenges for Microgrid Protection – Adaptive Protection for Microgrids – Fault Current Source for Effective Protection in Islanded Operation – Fault Current Limitation in Microgrids.		
Unit - V	**Operation of Multi-microgrids**	**9**
Introduction – Multi-microgrid control and Management Architecture – Coordination voltage/ VAR support – Coordinated Frequency Control – Emergency Functions – Dynamic equivalents.		

Total:45

TEXT BOOK:

1. Nikos Hatziargyriou, “Microgrids: Architectures and Control,” 1st Edition, Wiley-IEEE Press, USA, March 2014.

REFERENCES:

1. Magdi S. Mahmoud, “Microgrid: Advanced Control Methods and Renewable Energy System Integration”, Illustrated edition, Butterworth-Heinemann Publisher, United Kingdom, 2016
2. Sharkh S.M., Abu-Sara M.A., Orfanoudakis G.I. & Hussain B., “Power Electronic Converters for Microgrids,” 1st Edition, Wiley – IEEE Press, USA, June 2014

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the basic concept of microgrid and its operation	Understanding (K2)
CO2	identify the various microgrid control issues	Understanding (K2)
CO3	design the intelligent local controllers for microgrid	Applying (K3)
CO4	identify and describe various protection schemes suitable for microgrid	Understanding (K2)
CO5	analyze the function of multi-microgrid	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	1										3	2
CO2	2	1	3										1	3
CO3	2	1	3										3	2
CO4	2	1	3										1	3
CO5	3	2	2				1						2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE27 ELECTRICAL MACHINE DESIGN

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	This course aims in imparting knowledge to the students about fundamental aspects and consideration of different parameters for proper design of static and rotating dc and ac electrical rotating machines.	
Unit - I	**Introduction**	**9**
Major considerations in Electrical Machine Design – Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings – Thermal considerations – Heat flow – Temperature rise and Insulating Materials – Rating of machines – Standard specifications.		
Unit - II	**Dc Machines**	**9**
Output Equation – Main Dimensions – Choice of Specific Electric and Magnetic Loading – Magnetic Circuits Calculations – Carter's Coefficient – Net length of Iron – Real & Apparent flux densities –Selection of number of poles – Design of Armature – Design of commutator and brushes – performance prediction using design values.		
Unit - III	**Transformers**	**9**
Output Equations – Main Dimensions – kVA output for single and three phase transformers – Window space factor – Design of core and winding – Overall dimensions – Operating characteristics – No load current – Temperature rise in Transformers – Design of Tank – Methods of cooling of Transformers.		
Unit - IV	**Induction motors**	**9**
Output equation of Induction motor – Main dimensions – Choice of Average flux density – Length of air gap- Rules for selecting rotor slots of squirrel cage machines – Design of rotor bars & slots – Design of end rings – Design of wound rotor – Magnetic leakage calculations – Leakage reactance of polyphase machines- Magnetizing current – Short circuit current – Operating characteristics- Losses and Efficiency.		
Unit - V	**Synchronous machines**	**9**
Output equations – choice of Electrical and Magnetic Loading – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length – Design of rotor – Design of damper winding – Determination of full load field mmf – Design of field winding – Design of turbo alternators – Rotor design.		

Total:45

TEXT BOOK:

1. Sawhney A.K., "Electrical Machine Design", 3rd Edition, Dhanpat Rai & Co., New Delhi, 2017

REFERENCES:

1. Mittle V.N. & Mittle A., "Design of Electrical Machines", 4thEdition, Standard Publications and Distributors, New Delhi, 2005.
2. Agarwal R.K., "Principles of Electrical Machine Design", 4thEdition, S.K.Kataria & Sons, New Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	classify and compare the various fundamental aspects and materials used for electrical machine	Understanding (K2)
CO2	identify the design parameter of dc motor by considering load requirement	Applying (K3)
CO3	identify the design parameter of transformer by considering load requirement	Applying (K3)
CO4	identify the design parameter of induction motor by considering load requirement	Applying (K3)
CO5	identify the design parameter of Synchronous machines by considering load requirement	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											3	2
CO2	3	2	1	1									2	3
CO3	3	2	1	1									2	3
CO4	3	2	1	1									2	3
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	60	10				100
CAT2	30	50	20				100
CAT3	30	50	20				100
ESE	30	50	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE28 DIGITAL IMAGE PROCESSING AND MULTI RESOLUTION ANALYSIS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Signals and Systems	7	PE	3	0	0	3

Preamble	This course enables the students to learn and apply the various Digital Image Processing techniques on real time images.	
Unit - I	**Digital Image Fundamentals**	**9**
Elements of digital image processing systems, Elements of visual perception – Brightness – Contrast – Hue – Saturation – Mach band effect, Image sampling – Quantization, Basic relationship between pixels, Color image fundamentals – RGB – HSI models – Colour image quantization		
Unit - II	**Image Transforms**	**9**
Need for transforms, DFT and its Properties: Separable – Spatial shift – Periodicity –Scaling – Orthogonality – Rotation, DCT, KLT and SVD.		
Unit - III	**Image Enhancement**	**9**
Basic intensity transformations – Piecewise linear transformation functions, Histogram equalization, Spatial filtering : Smoothing and sharpening Filters, Frequency domain filtering : Smoothing and sharpening filters – Homomorphic filters. **Image Restoration:** Degradation model – Noise distributions – Median – Geometric mean – Harmonic mean – Contra harmonic mean filters – Order Statistics filters – Inverse and wiener filtering – Constrained least square filtering – Performance metrics – BSNR – ISNR – Applications		
Unit - IV	**Image Segmentation, Representation & Description**	**9**
Point, line and edge detection – Basics of intensity thresholding – Region based segmentation: Region growing – Region splitting and merging, Image representation : Chain codes, – Boundary descriptors – Regional descriptors		
Unit - V	**Wavelets And Multiresolution Processing**	**9**
Subband coding – The Haar Transform – Multiresolution Expansion – Series Expansion – Scaling Function – Wavelet Function – Wavelet Transform in One Dimension – The Wavelet Series Expansion – The Discrete Wavelet Transform – The Continuous Wavelet Transform – The Fast Wavelet Transform – Wavelet transform in two dimensions – Applications in image denoising – Image fusion –Steganography		

Total:45

TEXT BOOK:

1. Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”,4th Edition, Pearson Education, Chennai,2016

REFERENCES:

1. Jayaraman S, Esakkirajan S & Veerakumar T, “Digital Image Processing”,1st Edition 17th reprint, Tata McGraw Hill, New Delhi,2016
2. Chanda B & Dutta Majumder D, “Digital Image Processing and analysis”, 2nd Edition, PHI learning,New Delhi,2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the fundamental concepts of digital image processing , 2D sampling and Colour image models.	Applying (K3)
CO2	apply DFT, DCT, KLT, SVD and Haar transformations on an images	Applying (K3)
CO3	implement the image enhancement & image restoration techniques	Applying (K3)
CO4	explain image segmentation, representation and description techniques for image classification	Understanding (K2)
CO5	apply the multi resolution processing over images using wavelet transform.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1									1	3
CO2	3	2	1	1									3	3
CO3	3	3	3	1	2								3	1
CO4	3	3	3	1	2								2	3
CO5	3	2	1	1									3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE29 INDUSTRIAL AUTOMATION

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Electrical Measurements and Instrumentation	7	PE	3	0	0	3

Preamble	This course is aimed to impart knowledge on the technologies used for the automation in industries.	
Unit – I	**Introduction**	**9**
Architecture of the basic three level Integrated Industrial Automation Systems – Field level for sensors actuators and smart devices, Control level for process and motion control functions, Distributed control system - Supervisory level for Data logging and Acquisition systems – DAS and SCADA for Management functions - Integrated automation through bus structure at the different levels.		
Unit – II	**Field Level Equipment-Sensors**	**9**
Field level equipment – Sensors and measurement systems for Temperature, Pressure, Force, Displacement and speed measurement - Flow measurement techniques – Measurement of level, humidity, pH.		
Unit – III	**Field Level Equipment- Actuators**	**9**
Introduction to Actuators – solenoids, on/off valves-Proportional Flow Control Valves – Hydraulic Actuator Systems – Principles, Components and Symbols – Pumps , fans and Motors – Pneumatic Control Systems – System Components-Integrated Control Systems using Smart sensors, Hart communication protocol.		
Unit – IV	**Process Controls**	**9**
Introduction to process control – Automatic Process Control – Need for Automatic Process Control in Industry – Mathematical Modeling of Processes – First, Second and Higher Order Process Systems – Feed Forward Control – Cascade Control – Ratio Control – Selective Control Systems – Split-Range Control – Adaptive Controls – Inferential Control – Interacting Control Systems – Multi Variable Control.		
Unit – V	**PLC and HMI Controls**	**9**
Introduction to PLC-s, PLC-s and Relay controls – PLC processor modules -input/output modules – Parallel /Local and Serial / Remote I/O modules-power supplies for I/O modules – Selection of PLC based on I/O counts and Scan times, PLC programming Languages – Ladder logic, functional block diagram-On/ Off logic functions, timer / counter, Register functions – control instructions – PID controls, Arithmetic and other Math instructions – sequencer Instructions.		

Total:45

TEXT BOOK:

1. Krishnaswamy K, “Process Control”, 2nd Edition, New Age International(P) Ltd, NewDelhi, 2015. (Unit-4)
2. Frank D. Petruzella, “Programmable Logic Controllers”, 5th edition, McGraw Hill, New Delhi, 2019. (Unit-5)

REFERENCES:

1. NPTEL web book on Industrial Automation and controls by Mr. S.Mukhopadhyay and Mr.S.Sen of IIT, Kharagpur.
2. Bill Drury, “The Control Techniques Drives and Controls Handbook”, 2nd Edition, IET Power and Energy Series, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the integrated industrial automation system	Understand(K2)
CO2	utilize the Field level equipment-sensors for different industrial applications	Applying (K3)
CO3	utilize the Field level equipment-Actuators for different industrial applications	Applying (K3)
CO4	understand the Process controls in Industries	Understanding (K2)
CO5	apply the concepts of PLC in control oriented Industrial applications	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											1	2
CO2	3	2	1	1									2	3
CO3	3	2	1	1									2	3
CO4	3	1											1	2
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	40	10				100
CAT2	30	40	30				100
CAT3	30	40	30				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EET30 POWER QUALITY

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Power Electronics	8	PE	3	0	0	3

Preamble	This course would make the students aware about the various issues affecting the power quality as well as techniques available to improve the quality of power	
Unit - I	**Introduction to Power Quality**	**9**
Definitions – power quality, voltage quality – power quality issues: short duration voltage variations, long duration voltage variations, transients, waveform distortion, voltage imbalance, voltage fluctuation, power frequency variations – power quality terms – Computer Business Equipment Manufacturers Associations (CBEMA) curve – ITI curves.		
Unit - II	**Voltage Sags and Interruptions**	**9**
Sources of Sags and Interruptions, Estimating voltage Sag Performance, Fundamental Principles of Protection, Solution at the End –User Level, Motor – Starting Sags.		
Unit - III	**Transient over Voltages**	**9**
Sources of Transient Over voltages, Principles of Over voltage Protection, Devices for over voltage Protection, Utility Capacitor –Switching transients, Utility System Lightning Protection, Managing Ferro-resonance, Switching Transient Problems with Loads, Computer Tools for Transients Analysis		
Unit - IV	**Harmonics**	**9**
Introduction – definition and terms – harmonics, harmonics indices, inter harmonics, notching – voltage Vs current distortion – harmonics Vs transients – sources and effects of harmonic distortion – mitigation and control techniques – passive and active filters for harmonic reduction.		
Unit - V	**Power Quality Monitoring and Solutions**	**9**
Introduction – Power quality monitoring: Monitoring considerations – brief introduction to power quality measurement equipments and power conditioning equipments – Spectrum analyzers, harmonic analyzers and Smart power quality monitors – assessment of power quality – application of intelligent systems – basic design of expert system – Power quality: Monitoring standards		

Total: 45

TEXT BOOK:

1. Roger C. Dugan, Mark F. McGranaghan, H. Wayne Beaty, “Electrical Power Systems Quality”, 3rd Edition, McGraw-Hill, New York, Reprint 2013

REFERENCES:

1. Kennedy Barry W., “Power Quality Primer”, 1st Edition, McGraw-Hill, New York, 2000.
2. Bollen Math H.J., “Understanding Power Quality Problems: Voltage Sags and Interruptions”, 1st Edition, IEEE Press, New York, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the power quality issues in electrical distribution network	Understanding (K2)
CO2	evaluate the severity of voltage sag, voltage swell and transients in distribution networks	Understanding (K2)
CO3	analyze the effect of transient over voltages	Applying (K3)
CO4	identify the wiring-grounding problems and design circuits to mitigate harmonic issues	Applying (K3)
CO5	understand the importance of PQ monitoring and select equipments to measure power quality	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											3	2
CO2	3	1											3	2
CO3	3	2	1	1									2	3
CO4	3	2	1	1									2	3
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE31 SMART GRID

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Generation, Transmission and Distribution, Power Electronics	8	PE	3	0	0	3

Preamble	The aim of the course is to provide basic concepts, various control and automation Technologies, power electronics applications of smart grid.	
Unit - I	**Introduction**	**9**
Introduction: Need for implementing smart grid – Early Smart Grid initiatives – Overview of the technologies required for the Smart Grid – Data Communication: Switching techniques – Communication channels – Layered architecture and protocols.		
Unit - II	**Sensing, Measurement and Control**	**9**
Introduction – Smart metering – Evolution of electricity metering – Key components of smart metering – An overview of the hardware used – Communications infrastructure and protocols for smart metering – Demand-side integration – Phasor measurement unit (PMU).		
Unit - III	**Information and Communication Technologies**	**9**
Communication Technologies: Introduction – Communication technologies – standards for information exchange – Information security for smart grid: Encryption and decryption – Authentication – Cyber security standards – Introduction to cloud Computing.		
Unit - IV	**Automation Technologies**	**9**
Distribution automation equipment: Substation automation equipment – Faults in the distribution system – Voltage regulation-Distribution management system: Data sources and external systems – Modelling and analysis tools – Applications.		
Unit - V	**Power Electronics and Energy Storage in Smart Grid**	**9**
Power Electronics**:** Introduction – Renewable energy generation – Fault current limiting – Shunt compensation – Series compensation. Energy storage: Introduction – Energy storage technologies – Case study.		

Total:45

TEXT BOOK:

1. Janaka Ekanayake, Kithsiri Liyanage, JianzhongWu, Akihiko Yokoyama & Nick Jenekins, “Smart Grid:Technology and Applications”,1st Edition, John Wiley& Sons Ltd, United Kingdom, 2012.

REFERENCES:

1. James Mamoh, “Smart Grid Fundamentals of Design and Analysis”, 1st Edition, IEEE Press, John Wiley and Sons, Canada, 2012.
2. FereidoonP. Sioshansi ,“Smart Grid–Integrating renewable, distributed and efficient energy”, 1st Edition, Academic Press,United States, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the need for implementing smart grid and transmission system operation	Understanding (K2)
CO2	apply the sensing, measurement and control techniques for smart grid applications	Applying (K3)
CO3	identify the information and communication technologies in smart grid	Understanding (K2)
CO4	evaluate the automation technologies in smart grid	Applying (K3)
CO5	analyse the applications of power electronics and energy storage in smart grid	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3		2										3	
CO2	3	3	2										1	
CO3	3		2										2	
CO4	3	2	2										2	
CO5	3	3	3										2	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	70	10				100
CAT2	30	50	20				100
CAT3	20	50	20	10			100
ESE	20	50	20	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE32 HYBRID ELECTRIC VEHICLES

Programme & Branch	B.E.- Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	PE	3	0	0	3

Preamble	This course is aimed to introduce the fundamental concepts and principles of various Hybrid Electric Vehicle technologies with an insight into Power electronic converters and topologies.	
Unit - I	**Introduction to Electric and Hybrid Electric Vehicles**	**9**
Environmental impact and history of modern transportation – Electric vehicles: configuration of EVs- performance of EVs – Tractive effort in normal driving- energy consumption – Hybrid electric vehicles: concept of hybrid electric drive trains – Architecture of hybrid electric drive trains.		
Unit - II	**IC propulsion and Electric Propulsion Systems**	**9**
Vehicle power plant and transmission characteristics – IC engine operating principle- operation parameters – DC Motor Drives – Induction Motor Drives – Permanent Magnetic BLDC Motor Drives – SRM Drives.		
Unit - III	**Electrically Coupled Hybrid Electric Drive Train**	**9**
Design principle of series (electrical coupling) hybrid electric drive train: Operation patterns – Control strategies – Design principles of a series (electrical coupling) hybrid drive train – Design example: Design of traction motor size – Design of the gear ratio – Verification of acceleration performance – Design of the power capacity of PPS – Fuel Consumption.		
Unit - IV	**Mechanically Coupled Hybrid Electric Drive Train**	**9**
Parallel (mechanically coupled) hybrid electric drive train design: Drive train configuration and design objectives – Control strategies – parametric design of a drive train – Design and control methodology of series – parallel (torque and speed coupling) hybrid drive train: Drive train configuration – drive train control methodology – design and control principles of plug-in hybrid electric vehicles.		
Unit - V	**Fundamentals of Regenerative Breaking**	**9**
Braking energy consumed in urban driving – braking energy versus vehicle speed – braking energy versus braking power – braking power versus vehicle speed – braking energy versus vehicle deceleration rate – braking energy on front and rear axles – brake system of EV, HEV, and FCV.		

Total: 45

TEXT BOOK:

1. Mehrded Ehsani, Yimin Gao & Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Edition, CRC Press , USA, 2010.

REFERENCES:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd Edition, CRC Press, USA, 2011.
2. Chris Mi, Abul Masrur M & David Wenzhong Gao, "Hybrid Electric Vehicles Principles And Applications With Practical Perspectives", 1st Edition, Wiley Publication, UK, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain about concept of electric and hybrid electric vehicles	Understanding (K2)
CO2	distinguish the characteristics of internal combustion vehicles and hybrid electric vehicles	Applying (K3)
CO3	demonstrate the concept of electrically coupled hybrid electric drive trains	Understanding (K2)
CO4	illustrate the concept of mechanically coupled hybrid electric drive trains	Applying (K3)
CO5	outline the importance of regenerative breaking	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1									2	3
CO2	3	2	1	1									2	3
CO3	3	2	1	1									2	3
CO4	3	1											3	2
CO5	3	2	1	1									2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20				100
CAT2	30	40	30				100
CAT3	20	40	40				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE33 ELECTRICAL MACHINE CONTROL AND MAINTENANCE

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	DC Machines and Transformers, Synchronous and Induction Machines	8	PE	3	0	0	3

Preamble	The objective of the course is to understand the construction and operations of control circuit components and industrial controls used in various applications. To provide fundamental knowledge in maintenance, installation, testing and troubleshooting measures for DC and AC machines.	
Unit - I	**Control Circuit Components**	**9**
Introduction – Fuses – Contactors and its Rating – Control Circuit Relays – Time Delay Relays – Phase Fault Relays – Solenoid Valves – Pressure Switch – Temperature Switch – Float Switch – Push Button and Selector Switch – Symbols of Control Components		
Unit - II	**Industrial Control**	**9**
Automatic Control for a Water Pump – Lifting Magnet – Electrical Oven – Overhead Crane – Battery Trolley – Air Compressor – Conveyor System – Starter: Two and Three Point Starter – Star/Delta Starter – Rotor Resistance Starter		
Unit - III	**Maintenance, Installation and Testing**	**9**
Importance of Electrical Maintenance – Types of Maintenance – Preventive Maintenance for Induction Motor, Alternator, DC Machines, Transformer – Factor Affecting the Preventive Maintenance – Installation and Commissioning of Induction Motor – Vibration – Installation and Commissioning of Transformer – Testing of Motor and Transformer		
Unit - IV	**Troubleshooting of AC Machines**	**9**
Significance of Trouble shooting – Types of Faults and Precaution – Instruments for Maintenance – Classifications of Fault in Rotating Electrical Machines – Abnormal Conditions – Trouble Shooting of AC – Noise and Vibration – Bearing Maintenance		
Unit - V	**Troubleshooting of DC Machines and Transformer**	**9**
Trouble Shooting of DC Motors – Commutator and Brushes – Transformer Types – Determination of Transformer Defects – Troubleshooting of Power and Distribution Transformer – Repairing of Transformer – Inspection – Measurement of Insulation Resistance using Megger		

Total: 45

TEXT BOOK:

1. S.K.Bhattacharya and Brijinder Singh, “Control of Machines”, 2nd Edition, New Age International Publishers, New Delhi, 2006 for Unit I,II.
2. Madhvi Guptha, “Installation, Maintenance and Repair of Electrical Machines and Equipments”, 4th Edition, S.K. Kataria & Sons, New Delhi, 2014 for Unit III,IV, V.

REFERENCES:

1. Sunil S. Rao, “Testing Commissioning Operation & Maintenance Of Electrical Equipments”, 6th Edition, Khanna Publishers, New Delhi, 1991.
2. Charles Kingsley Jr., A.E. Fitzgerald and Stephen D.Umans, “Electric Machinery”, New York, McGraw-Hill Higher Education, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the construction and operation of various control circuit components	Understanding (K2)
CO2	analyze the power and control circuit operation involved in the modern industries	Applying (K3)
CO3	explain the maintenance, Installation and Testing procedure for AC and DC machines	Understanding (K2)
CO4	confidently troubleshoot the faults concerned in high power AC machines	Understanding (K2)
CO5	confidently troubleshoot the faults in high power DC machines and Transformer	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	1										2	
CO2	3	1	2										3	
CO3	3	2	1										2	
CO4	3	1	1										3	
CO5	3	2	1										3	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20				100
CAT2	30	50	20				100
CAT3	30	60	10				100
ESE	30	50	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE34 DIGITAL SIGNAL PROCESSORS AND ITS APPLICATIONS

Programme & Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Signals and Systems	8	PE	3	0	0	3

Preamble	This course helps the students to impart the knowledge on filter design, DSP processor and its real time applications	
Unit - I	**FIR Filter**	**9**
FIR Filter Design: Amplitude and phase responses of FIR filters – Linear phase filters – symmetrical linear phase filter, asymmetrical linear phase filter – windowing techniques for design of linear phase FIR filters – Rectangular, Hamming, Hanning		
Unit - II	**IIR Filter**	**9**
IIR Filter Design (low pass and high pass): Review of design of analogue Butterworth and Chebychev Filters, frequency transformation in analog domain – design of IIR digital filters using impulse invariance technique – design of IIR digital filters using bilinear transformation technique – pre warping – Frequency transformation in digital domain.		
Unit - III	**DSP Processors**	**9**
Architecture and Features of TMS320C5416 DSP Processor, Instruction set, Addressing Modes – Architecture and features of TMS320F2812 DSP processors – Addressing modes – Introduction to Commercial DSP processors.		
Unit - IV	**Realization of Filter Structure and Applications**	**9**
Realization of FIR filters – Direct, cascade, linear phase structures. IIR Filter structure realization – Direct, cascade, and parallel forms. DSP Applications: Harmonic Analysis, Motor Control, Power line communication.		
Unit - V	**Multirate Digital signal processing**	**9**
Sampling rate conversion – Decimation – Interpolation – Fractional sampling rate alteration – signal flow graphs – filter structures – digital filter design – multistage decimators and interpolators.		

Total:45

TEXT BOOK:

1. Salivahanan. S, “Digital Signal Processing”, 4th Edition, Tata McGraw Hill Education, New Delhi, 2019

REFERENCES:

1. John.G.Proakis, Dimitris.G.Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, 5th Edition, Pearson Education, India, 2021
2. Baris Bagci, "Programming and Use of TMS320F2812 DSP to Control and Regulate Power Electronic converters", 1st Edition, Grin Publishing, Munich, Germany, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design and analyze the FIR filters	Analyzing (K4)
CO2	design the analyze IIR filters	Analyzing (K4)
CO3	explain the architecture of advanced DSP processors	Understanding (K2)
CO4	realize FIR and IIR filter structures	Applying (K3)
CO5	explain multirate digital signal processing and digital filter design	Understanding(K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	2	2	1								1	3
CO2	2	3	2	2	1								1	3
CO3	2	3											1	3
CO4	3	2	1	1									1	3
CO5	2	3											1	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	10	50	30			100
CAT2	10	10	50	30			100
CAT3	10	40	50				100
ESE	10	10	50	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEE35 ELECTRIC POWER UTILIZATION

Programme& Branch	B.E & Electrical and Electronics Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	PE	3	0	0	3

Preamble	The course aims in imparting knowledge on Electric heating, Electric Welding, Electric traction, Fans, Pumps, and Lighting systems	
Unit - I	**Electric Heating**	**9**
Electric Heating – Advantages- Methods of Electric heating – Resistance heating – requirement of a heating element – design of heating element – Arc furnaces – Induction heating- Core type Induction Furnace and Coreless Induction furnace – Eddy current Heating		
Unit - II	**Electric Welding**	**9**
Welding – Welding processes – Electrodes for metal arc welding – Arc Welding machines – VI characteristics – DC welding machine with motor-generator set – AC Welding Machines, Types of Welding – TIG, MIG, MAG, resistance Welding, Spot Welding, Butt Welding, Projection Welding and Electron Beam Welding		
Unit - III	**Electric Traction**	**9**
Introduction – requirements of an ideal traction system – supply systems – speed time curves for train movement – calculation of average and crest speed of various services – mechanics of train movement – tractive effort – specific energy consumption – calculation of specific energy consumption on a level track		
Unit - IV	**Fans and Pumps**	**9**
Fans – Types, Characteristics and Typical applications, Fan curves – Fan Laws – Flow Control Strategies – Energy Saving Opportunities in fans – Pumps: Types, System Characteristics, Pump curves – Flow control strategies – Energy Conservation opportunities in Pumps		
Unit – V	**Lighting Systems**	**9**
Basic Parameters and Terms in Lighting systems – Light sources and Lamp Types – Luminous performance Characteristics of commonly used luminaries – Methods of calculating illuminance – Lighting design for Interiors – Energy saving opportunities in lighting systems		

Total:45

TEXT BOOK:

1. Gupta J.B, “Utilization of Electric Power and Electric Traction”, 10th Edition, S.K. Kataria& Sons, New Delhi, 2012 for Unit I,II,III.
2. “Energy Efficiency in Electrical Utilities”, Guide Book for National Certification Examination for energy managers and Auditors, 4th Edition, Bureau of Energy Efficiency,2015 for Units IV,V.

REFERENCES:

1. Taylor E. Openshaw, “Utilization of Electrical Energy”, Universities Press, Hyderabad, 2012
2. Chakrabarti A., Soni M.L., Gupta P.V. and Bhatnagar U.S., “A Textbook on Power System Engineering”, DhanpatRai& Co., New Delhi, 2013

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	discuss the applications of electrical energy for heating	Understanding(K2)
CO2	outline the applications of electrical energy for welding	Understanding(K2)
CO3	discuss electric traction systems and their performance	Applying(K3)
CO4	discuss fans and blowers and appraise the energy saving opportunities in them	Understanding(K2)
CO5	describe the lighting systems, lighting design and appraise the energy saving opportunities in them	Applying(K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											2	1
CO2	3	1											2	1
CO3	3	3	2	2									2	3
CO4	3	1											2	1
CO5	3	1											2	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	80					100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEO01 SOLAR AND WIND ENERGY SYSTEMS

Programme & Branch	All Branches of B.E., / B.Tech.,	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	This course aims in imparting the concepts and nuances of solar and wind energy systems along with its detailed design procedures and analysis.	
Unit - I	**Introduction to Solar PV**	**9+3**
Solar cell – Parameters of solar cell – Solar PV module – Ratings and parameters – Measuring module parameters – Solar PV module arrays – Factor affecting electricity generation by a solar cell and solar PV module.		
Unit - II	**Types of PV Systems**	**9+3**
Stand alone, grid connected and hybrid systems – Battery parameters – Battery selection – Charge controllers – DC-DC converters – Inverters – MPPT – Components of grid connected PV systems.		
Unit - III	**Solar PV system Design**	**9+3**
Design methodology for solar PV system: Approximate design of solar PV system – Solar PV system design chart – Look up table for solar PV system design – Installation and troubleshooting of solar PV power plants.		
Unit - IV	**Introduction to WECS**	**9+3**
Power output from an ideal turbine – Aerodynamics – Power output from practical turbines – Energy production and capacity factor – Methods of generating synchronous power – DC shunt generator with battery load – AC generators.		
Unit - V	**Wind Power Plant Design**	**9+3**
Site preparation – Electrical network – Selection of low voltage and distribution voltage equipments – Losses – Wind farm costs.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems – A Manual for Technicians, Trainees and Engineers", 1st Edition, PHI learning Private Limited, New Delhi, 2013 for Units I,II & III
2. Gary L.Johnson, "Wind Energy Systems", Electronic Edition, Manhatan, KS, 2006 for Units IV & V

REFERENCES:

1. Chetan Singh Solanki, "Solar Photovoltaics – Fundamentals, Technologies and Applications", 2nd Edition, PHI learning Private Limited, New Delhi, 2011.
2. Spera, D.A., "Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering", 2nd Edition, ASME, New York, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Outline the parameters and ratings of solar cell and modules	Understanding (K2)
CO2	Make use of various components intended for solar PV system design	Applying (K3)
CO3	Apply the design procedures for solar PV systems towards installation	Applying (K3)
CO4	Identify the required components for wind energy conversion system	Understanding (K2)
CO5	Examine the design and installation procedures for WECS	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	3				1							
CO2	2	3	2				1							
CO3	2	3	2				1							
CO4	2	2	3				1							
CO5	2	3	2				1							
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEO02 ELECTRICAL WIRING AND LIGHTING

Programme & Branch	All Branches of B.E., / B.Tech.,	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	OE	3	1	0	4

Preamble	Lighting becomes one of the essential requirements for the humans on day to day activities. Hence it is necessary to educate an engineer in the aspects of Domestic and Industrial Lighting. The idea of the subject is to educate the electrical engineers on the aspect of Introduction to Wiring and its Design considerations, Installations, Light and Luminaires and Light sources.	
Unit - I	**Introduction**	**9+3**
Electric supply system – List of Electrical Symbols and its interpretation – Electrical Diagrams – System of connection of Appliances and accessories – Example circuits – Panel Boards – Earthing – Different types of wires, wiring system, methods and materials – Fuse Calculation and Circuit breakers – Wiring Tools – IE rules for wiring		
Unit - II	**Domestic Wiring**	**9+3**
Three phase four wire distribution system – Protection – General requirements of electrical installations – Testing of installations – Types of Loads – Service connections – Service mains – Sub-Circuits – Location of main board and Distribution board – Guidelines for installation of fittings – Voltage drop and size of wires – safety		
Unit - III	**Industrial Wiring**	**9+3**
Electrical installation for residential buildings - Estimating and costing of material – Solved examples for residential buildings with Problems – Electrical installations for commercial buildings –Electrical installations for small industries		
Unit - IV	**Illumination**	**9+3**
Introduction – Terms & Definitions – Laws of Illumination – Polar curves – Photometry – Basic principles of Light control – Types of Lighting Schemes – Design of Lighting Schemes – Methods of Lighting calculation with Problems – Factory, Street & Flood Lighting		
Unit - V	**Light Sources**	**9+3**
History of the electric lamp – Arc lamps – Incandescent Lamps – Gaseous discharge lamps : Sodium vapour discharge lamp, High pressure mercury vapour discharge lamp, Mercury iodide lamp, Neon lamp, Fluorescent Tubes, CFL – LED's		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Raina K.B & Bhattacharya S.K, "Electrical Design Estimating and Costing", 2nd Edition, New Age International Publishers, 2017 for Unit I,II,III
2. Gupta J.B, "Utilization of Electric Power and Electric Traction", 10th Edition, S.K.Kataria & Sons, 2012 for Unit IV,V

REFERENCES:

1. Pritchard D.C, "Lighting" , 6th Edition, Routledge, 2016
2. Ronald N. Helms, "Illumination Engineering for energy efficient luminous environments", 1st Edition, Prentice–Hall, Inc, 1980

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Discuss the various methods in wiring	Understanding (K2)
CO2	Infer the different design considerations in Domestic wiring	Understanding (K2)
CO3	Demonstrate the various Electrical Installations	Applying (K3)
CO4	Describe the various lighting and its controls	Understanding (K2)
CO5	Demonstrate the various types of light sources	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1	1	1									
CO4	3	2	1											
CO5	3	2	1	1	1									
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60					100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEO03 ENERGY CONSERVATION AND MANAGEMENT

Programme & Branch	All Branches of B.E., / B.Tech.,	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	This course aims in imparting the procedures of energy audit, energy management and financial management. Also it aims to impart knowledge on energy conservation opportunities in thermal utilities, electrical system, lighting Systems and in buildings.	
Unit - I	**Introduction**	**9+3**
Classification of Energy - Energy Scenario - Energy Needs of Growing Economy - Energy Pricing in India – Energy and Environment - Energy Conservation Act . Energy Audit: Types and Methodology - Energy Audit Instruments - Role of energy managers and auditors		
Unit - II	**Thermal Utilities**	**9+3**
Steam – Introduction, Properties of steam, Steam distribution systems , Boilers- Types and Classification- Performance Evaluation of Boilers – Losses in Boiler – Energy Conservation opportunities in boilers, Waste heat recovery - Classification and benefits		
Unit - III	**Electrical and Lighting System**	**9+3**
Introduction to Electric Power Supply Systems - Electrical Load Management and Maximum Demand Control- Power factor improvement and its benefit, Basic Parameters and Terms in Lighting systems - Luminous performance Characteristics of commonly used luminaries and Energy saving opportunities in lighting systems		
Unit - IV	**Energy Conservation in Buildings and ECBC**	**9+3**
About ECBC – Building Envelope , Fenestrations, Insulation, HVAC , Lighting , Water pumping , Inverter – Elevators and Escalators – Star Labeling for existing buildings		
Unit - V	**Financial Management**	**9+3**
Investment – need, Appraisal and criteria, Financial analysis techniques – Simple payback period – Return on investment – Net present value – Internal rate of return – Cash flows, Risk and sensitivity analysis – Financing options – Energy performance contracting and role of ESCOs.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Guide Books for National Certification Examination for energy managers and Auditors, 3rd Edition, Bureau of Energy Efficiency,2010

REFERENCES:

1. Wayne C. Turner & Steve Doty, “Energy Management Handbook”, 6th Edition, The Fairmont Press, GA,2006
2. Barny L. Capehart, Wainey C. Turner, William J. Kennedy, “Guide to Energy Management”, 7th Edition, The Fairmont Press, GA, 2012

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the importance of energy, energy conservation and energy audit	Understanding (K2)
CO2	appraise the energy saving opportunities in thermal systems	Understanding (K2)
CO3	predict the energy saving opportunities in lighting systems	Applying (K3)
CO4	appraise the energy conservation in buildings and ECBC	Understanding (K2)
CO5	analyze the different financial management techniques	Analyzing (K4)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1												
CO2	3	1												
CO3	3	2	1											
CO4	3	1												
CO5	3	3	2		1									
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60					100
CAT2	20	40	40				100
CAT3	20	40	30	10			100
ESE	20	40	30	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEO04 AI WITH MATLAB

Programme & Branch	All Branches of B.E., / B.Tech.,	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	1	0	4

Preamble	This course aims in imparting the concepts and nuances of artificial intelligence and its step by step implementation procedure using MATLAB software.	
Unit - I	**Introduction to MATLAB programming**	**9+3**
Basic operations- Plotting – Programming – Debugging – Simulink.		
Unit - II	**Introduction of ANN**	**9+3**
Fundamental Concept- Basic models – Important Terminologies – Supervised learning: Perceptron, BPN – Unsupervised learning: Kohonen SOM, LVQ.		
Unit - III	**ANN with MATLAB**	**9+3**
ANN using GUI – ANN using Program codes: Perceptron, BPN and Kohonen SOM – ANN using Simulink: motor speed control.		
Unit - IV	**Introduction of Fuzzy Logic**	**9+3**
Fuzzy logic principle – Membership functions – Fuzzy rule base – Defuzzification methods - Application of FLC Systems.		
Unit - V	**Fuzzy logic system with MATLAB**	**9+3**
FIS using FLC using GUI - Fuzzy Logic using Program codes – FLC using Simulink: motor speed control.		

Lecture:45, Tutorial:15, Total:60

TEXT BOOK:

1. Sivanandam S N and Deepa S N, “Principles of Soft Computing”, 1st Edition, Wiley India, 2008 for Units II,III,IV & V
2. Amos Gilat, “MATLAB- An Introduction with Applications”, 4th Edition, Wiley India, 2012 for Uni I

REFERENCES:

1. Shailendra Jain, “Modelling and Simulation using MATLAB- Simulink”, 1st Edition, Wiley India, 2012.
2. MATLAB Software

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	outline the basic programming procedures using MATLAB software	Understanding (K2)
CO2	make use of ANN for solving engineering problems with aid of different learning methods	Applying (K3)
CO3	apply the various ANN design procedures with MATLAB	Applying (K3)
CO4	understand the fundamental components of fuzzy logic	Understanding (K2)
CO5	examine the fuzzy based design procedures for solving real time problems	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	3											
CO2	2	3	2											
CO3	2	3	2											
CO4	2	2	3											
CO5	2	3	2											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEO05 MICRO GRID AND SMART GRID

Programme & Branch	All Branches of B.E., / B.Tech.,	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	The course content is designed to study about micro grid standalone autonomous system, smart grid technologies, information and communication technologies. It is used to get familiarized with smart metering and control of smart grid systems. The course also aims in imparting knowledge on power electronics and energy storage.	
Unit - I	**Microgrid Concept**	**9**
Introduction – Renewable Power Generation – Grid Connected Wind Power – Grid Connected PV Power – Microgrid Concept and Structure – Operation Modes.		
Unit - II	**Microgrid Planning and Energy Management**	**9**
Introduction – Microgrid planning- Forecasting techniques – Energy Management – Emission reduction and Economical Optimization – Robust Energy Consumption Scheduling in Interconnected Microgrids.		
Unit - III	**Smart Grid and Communication Technologies**	**9**
Introduction to Smart grid – Smart grid initiatives – Overview of technologies required for smart grid – Information and communication technologies – Data communication – Communication technologies for smart grid – Information security for smart grid**.**		
Unit - IV	**Sensing, Measurement, Control and Automation Technologies**	**9**
Smart metering and demand side integration – Distribution automation equipment – Distribution management systems – Transmission system operation.		
Unit - V	**Power Electronics and Energy Storage**	**9**
Power electronic converters – Power electronics in smart grid – Power electronics for bulk power flows – Energy storage.		

Total:45

TEXT BOOK:

1. Hassan Bevrani, Bruno Francois & Toshifumi Ise, “Microgrid Dynamics and Control”, 1st Edition, Wiley, 2017 for Units I & II.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, AkihikoYokoyama, “Smart Grid: Technology and Applications”, 1st Edition, Wiley & Sons Ltd, 2012 for Units III, IV & V.

REFERENCES:

1. Chowdhury S, Chowdhury S.P & Crossley P, “Microgrids and Active Distribution Networks”, 1st Edition, The Institution of Engineering and Technology, 2009.
2. Tony Flick & Justin Morehouse, “Securing the Smart Grid Next Generation Power Grid Security”, 1st Edition, Elsevier, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the concepts of micro grid.	Understanding (K2)
CO2	assess the micro grid planning and energy management	Understanding (K2)
CO3	analyze the smart grid and its communication technologies.	Applying (K3)
CO4	interpret the sensing, measurement, control and automation technologies.	Applying (K3)
CO5	examine about the power electronics in smart grid and energy storage.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1												
CO2	3	1												
CO3	3	2	1	1										
CO4	3	2												
CO5	3	2												
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60					100
CAT2	30	60	10				100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEO06 ELECTRICAL SAFETY

Programme & Branch	All Branches of B.E., / B.Tech.,	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	OE	3	0	0	3

Preamble	This course imparts the knowledge about the electrical hazards and its safety measures in electrical systems.	
Unit - I	**Hazards Of Electricity**	**9**
Introduction: Objective of safety - Safety Oath, National safety day – Types of safety – Common safety measures – Types of Hazards – Hazards associated with electrical current and voltage – Electrical safety. Definition of terms: Electric shock, Arc and blast. Shock: Impact of electric shock – Influencing factors. Arc – Initiation of Arc – Impacts of Arc – Arc energy release: Arc energy input – Arcing voltage – incident energy – measurement – copper calorimeter – Stoll curve. Blast – Attributes of blast.		
Unit - II	**Personnel Protection Equipment(PPE)**	**9**
Flash and thermal protection: Glossary of terminologies – flame resistant, arc thermal performance value (ATPV), energy breakthrough (EBT) – ASTM standard for clothing materials – choice of clothing – flame and non-flame resistant materials – guidelines for selection – Flash Suit. Head Protection: Hard hats – ANSI Z 89.1 standard – Eye Protection - requirements of safety glasses, goggles – selection - Face shield. Hearing Protection – Requirement –ear plugs and ear muffs – Noise reduction ratio – thumb rule. Arm and Hand Protection: Rubber gloves – ASTM standards – leather protective glove – level of protection. Foot and leg protection and respiratory protection.		
Unit - III	**Electrical Safety Equipment**	**9**
Voltage measuring instruments: Safety voltage measurement – contact and non-contact type testers – selection criteria. Rubber Insulating equipment: Rubber mats, blankets, covers, line hoses and sleeves – Inspection techniques – standards. Insulated tools – hot sticks – cherry picker – standards for tools – safety barriers and signs – safety tags, lock and locking devices. Fire extinguishers – fire safety against electrical fire – types of extinguishers.		
Unit - IV	**Safety Earthing Practices**	**9**
Distinction between system grounding and equipment grounding – Functional requirement of earthing systems – earth electrodes – types. Earth Mats – Procedure for laying earthmat – earth resistance measurements – procedures and standards – step potential, touch potential – system grounding practices – advantages – types of grounding.		
Unit - V	**First aid and Rescue**	**9**
First Aid: First aid against electric shock, choking, poisoning, wounds and bleeding, burns and scalds, fractures and dislocations, heat stroke and snake bite. Rescue: Primary rescue methods – American Red Cross method. Types: elevated rescue, confined space rescue and ground level rescue. Regulatory Bodies: Functionality – IEEE, IEC, ASTM, NFPA and OSHA.		

Total:45

TEXT BOOK:

1. John Cadick., Mary Capelli Schellpfeffer & Dennis Neitzell., “Electircal Safety Handbook” , McGraw Hill Publishers, 4th Edition, 2012.

REFERENCES:

1. Rao.S, Jain R.K & Saluja H.L., “Electrical Safety, Fire Safety Engineering and Safety Management” Khanna Publishers, 2nd Edition, 1997.
2. Peter E. Sutherland., “Principles of Electrical Safety” IEEE Press Series on Power Engineering, John Wiley and Sons, New Jersy, March 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Understand the various terminologies and hazards related to electrical safety	Understand (K2)
CO2	Identify and apply the personnel protection equipment for a typical industry	Applying (K3)
CO3	Apply the various measuring and insulating equipment's for electrical safety	Applying (K3)
CO4	Apply the safety earthing practices for LV and HV system	Applying (K3)
CO5	Understand the functionality of international regulatory bodies , first-aid and rescue procedures	Understand (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1											
CO2	3	1	2											
CO3	3	1	2											
CO4	2	1	3											
CO5	1	2	3											
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	30	30	-	-	-	100
CAT2	40	20	40	-	-	-	100
CAT3	50	40	10	-	-	-	100
ESE	30	40	30	-	-	-	100

*** ±3% may be varied (CAT 1, 2, 3 – 50 marks & ESE – 100 marks)**

20EEO07 ELECTRIC VEHICLE

Programme & Branch	All Branches of B.E., / B.Tech.,	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	OE	3	0	0	3

Preamble	This course is aimed to introduce the fundamental concepts and principles of various Electric Vehicle technologies with an insight into configuration, propulsion system, energy sources and hydrid electric vehicles.	
Unit - I	**Introduction to EVs**	**9**
Importance of Different Transportation Development Strategies to Future Oil Supply - History of EVs - General Description of Vehicle Movement - Configurations of EVs - Performance of EVs: Traction Motor Characteristics - Tractive Effort and Transmission Requirement - Vehicle Performance - Tractive Effort in Normal Driving - Energy Consumption.		
Unit - II	**Electric Propulsion Systems**	**9**
Induction Motor Drives: Basic Operation Principles of Induction Motors - Power Electronic Control - Field Orientation Control - Voltage Source Inverter for FOC - Permanent Magnetic BLDC Motor Drives: Basic Principles of BLDC Motor Drives - BLDC Machine Construction and Classification - SRM Drives: Basic Magnetic Structure - Modes of Operation - Sensorless Control.		
Unit - III	**Power Sources and Energy Storages**	**9**
Electrochemical Batteries: Electrochemical Reactions - Thermodynamic Voltage - Specific Energy - Specific Power - Energy Efficiency - Battery Technologies - Lead–Acid Battery - Nickel-Based Batteries - Lithium-Based Batteries – Ultracapacitors - Ultra-High-Speed Flywheels - Hybridization of Energy Storage.		
Unit - IV	**Hybrid Electric Vehicles**	**9**
Concept of Hybrid Electric Drive Trains - Architectures of Hybrid Electric Drive Trains: Series Hybrid Electric Drive Trains (Electrical Coupling) - Parallel Hybrid Electric Drive Trains (Mechanical Coupling) - Hybrid Drive Trains with Both Torque and Speed Coupling.		
Unit - V	**Fuel Cell Hybrid Electric Drive Train**	**9**
Operating Principles of Fuel Cells - Fuel Cell System Characteristics - Fuel Cell Technologies - Fuel Supply - Fuel Cell Hybrid Electric Drive Train Design: Configuration - Control Strategy - Parametric Design.		

Total: 45

TEXT BOOK:

1. Mehrded Ehsani, Yimin Gao & Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Edition, CRC Press, USA, 2010.

REFERENCES:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd Edition, CRC Press, USA, 2011.
2. Chris Mi, Abul Masrur M & David Wenzhong Gao, "Hybrid Electric Vehicles Principles And Applications With Practical Perspectives", 1st Edition, Wiley Publication, UK, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the importance and different configurations of electric vehicles	Understanding (K2)
CO2	distinguish the characteristics of various motor drives for EVs	Understanding (K2)
CO3	identify the importance of energy storage systems in EVs	Applying (K3)
CO4	illustrate the concept of hybrid electric drive trains	Applying (K3)
CO5	demonstrate the concept of fuel cell drive train in Hybrid EVs	Understanding (K2)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1										
CO2	3	2	1	1										
CO3	2	3	1	1										
CO4	3	2		1										
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	60					100
CAT2	30	40	30				100
CAT3	20	40	40				100
ESE	30	40	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20EEO08 E Waste Management

Programme & Branch	EEE	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	8	OE	3	0	0	3

Preamble	This course covers various aspects of Waste from Electrical and Electronic Equipment, E-waste disposal along with recycling with an integrated approach. It also gives an insight into the management of special waste and domestic hazardous waste.	
Unit – I	**Introduction**	**9**
Waste Electrical and Electronic Equipment (WEEE) - The Scale of the Problem - Electronics Recycling - Treatment Options for WEEE - Material Composition of WEEE - Socio-economic Factors - International Perspective - Barriers to Recycle - Health and Safety Implications – Influence factors - Materials Used in Manufacturing Electrical and Electronic Products - Soldering and the Move to Lead-free Assembly - Printed Circuit Board Materials - Mobile Phones – Televisions - WEEE Engineering Thermoplastics.		
Unit – II	**Waste Disposal and Recycling**	**9**
Introduction - Landfill - Pollution from Landfills - Landfill Gas - Landfill-site Construction – Burning - Energy Recovery/Energy from Waste (EFW) - Advanced Thermal Processing - Pollution from Incineration – Recycling and recovery: Separation and Sorting – Treatment - Outputs and Markets - Emerging Technologies – Separation – Treatments – Extraction.		
Unit – III	**Integrated Approach to E-waste Recycling**	**9**
Introduction - Recycling and Recovery Technologies - Sorting/Disassembly - Crushing/Diminution - Separation - Emerging Recycling and Recovery Technologies - Automated Disassembly - Comminution – Separation - Thermal Treatments - Hydrometallurgical Extraction - Dry Capture Technologies - Biotechnological Capture - Sensing Technologies - Design for Recycling and Inverse Manufacturing - Printed Circuit Boards - Recycling - Characteristics of PCB Scrap - Emerging Technologies - Sector-based Eco-design		
Unit – IV	**Recycling of Display Devices and ERP**	**9**
Introduction - Overview of Liquid Crystals - Classification - Architecture - Liquid Crystal Displays Based on Nematic Mesophase - Manufacturing Process – Environmental Lifecycle Analysis – Toxicity of LCD Constituents – Recycling. European Recycling Platform (ERP): Founding Principles – Structure - Scope of services - Operational Model - Key Performance Indicators.		
Unit – V	**Special Waste & Domestic Hazardous Waste Management**	**9**
Introduction - Existing Rules for the management of wastes - Guidance from the Integrated Solid Waste Management (ISWM) Hierarchy - Plastic Waste - Bio-medical Waste - Slaughterhouse Waste – E-Waste Management rules 2016 - Waste Tyres - Lead Battery Waste - Action Points for Awareness Generation.		

Total: 45

TEXT BOOK:

1. Hester R.E., Harrison R.M., "Electronic waste management", 1st Edition, Royal Society of Chemistry (RSC) publishers, Cambridge-UK, 2009. unit
2. "Municipal Solid waste Management Manual Part II", 1st Edition, CPHEEO, Ministry of Urban Development, Govt. of. India, New Delhi, 2016

REFERENCES:

1. Johri R., "E-waste: implications, regulations, and management in India and current global best practices", 1st Edition, TERI Press, New Delhi, 2008.
2. Tchobanoglous G., Theisen H., Viquel S.A., "Integrated Solid Waste Management: Engineering, Principles and Management issues", 1st Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1993.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the challenges and issues of E-wastes and its source of emerging with its barriers for recycling it.	Understanding (K2)
CO2	infer handling and processing the E wastes and its disposal & recovery.	Understanding (K2)
CO3	apply the treatment methods for the E waste recycling technologies.	Applying (K3)
CO4	understand the recycling procedures of LCD devices and infer the European Recycling Platform scheme	Understanding (K2)
CO5	utilize the waste disposal management rules and guidance for handling the special wastes and domestic hazardous waste management.	Applying (K3)

Mapping of COs with POs and PSOs														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1												
CO2	3	1												
CO3	3	2	1	1										
CO4	3	1												
CO5	3	2	1	1										
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50					100
CAT2	30	50	20				100
CAT3	30	50	20				100
ESE	30	50	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

Annexure – III

List of One credit courses, on-line courses and syllabi, Transfer of credits from UGC and AICTE approved institutions and Credit transfer from foreign universities under R2018 & R2020 (from the year 2021-22 onwards)

List of One credit courses:

Electrical CAD
Basics of Electronics and Circuit Designing
FPGA design for Signal and Image Processing
Real time Embedded System development using high performance ARM CORTEX M4 Processor
Introduction to IoT and its real time applications
Illumination and lighting Design

On line courses:

noc20-cs83/ The Joy of Computing using Python
noc20-ee65/ Introduction to Smart Grid
noc20-cs70/ Programming, Data Structures And Algorithms Using Python
noc20-cs66 / Introduction to internet of things
noc20-ee98/ Introduction to Embedded System Design
noc20-ee95 / Introductory Neuroscience & neuro-Instrumentation
noc20-ee67 / Advances in UHV Transmission and Distribution
Introduction to Embedded System Design
Wheeled Mobile Robots
Introduction to Internet of Things
Real Time Operating System
Data Base Management System

Annexure – IV

Syllabi for PhD courses under R2020 from the academic year 2021-22 onwards

Annexure – V

Online examination system to be followed for the April/May 2021 End Semester Examinations as given below:

Question Paper Pattern:

- Each Question paper will contain 75 Multiple Choice Questions (MCQ) with 15 questions from each unit.
- All the questions should be answered.
- Time duration: 90minutes.
- There is no negative marking

Examination Procedure:

- Students are allowed to answer the questions, one after another in ascending order only.
- Students are not allowed to answer previous questions.
- Without answering the current question, students are not allowed to move on to the next / subsequent questions.
- Once a question is answered and submitted, then the answer cannot be altered.