ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)

ಬುಲ್ ಟೆಂಪಲ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು – ೫೬೦ ೦೧೯

BMS COLLEGE OF ENGINEERING

(Autonomous college under VTU)

BENGALURU-560019

ELECTRICAL & ELECTRONICS ENGINEERING

Scheme V- VIII Semester

Syllabus V-VI Semester

2014-2018

BMSCOLLEGEOFENGINEERING, BENGALURU

Autonomous College under VTU

VISION	MISSION
Promoting prosperity of mankind by augmenting human resource capital through quality technical education& training	Accomplish excellence in the field of technical education through education, research and service needs of society

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

THIRD AND FOURTH YEAR SYLLABUS BOOK

With effect from A. Y. 2016 – 17

Table of Contents

AY	Academic Year
AAT	Alternative Assessment Tools
BOE	Board of Examiners
BOS	Board of Studies
CBCS	Choice Based Credit System
CGPA	Cumulative Grade Point Averages
CIE	Continuous Internal Evaluation
CO	Course Outcomes
DC	Departmental Core
GC	Group Core
HSS	Humanity and Social Science Courses
IC	Institutional Core
IE	Institutional Elective
IL	Institutional Lab
LTPS	Lecture-Tutorial-Practical-Self Study
NFTE	Not Fit for Technical Education
PCC	Professional Core Courses
PEC	Professional Elective Courses
PEO	Program Educational Objectives
PO	Program Outcomes
SEE	Semester End Examination
SGPA	Semester Grade Point Average
ST	Studio

DEPARTMENT VISION	DEPARTMENT MISSION
Facilitating the development of competent professionals capable of adapting to the constantly changing global scenario in the field of Electrical Sciences	• Impart quality technical education and encourage research in the field of Electrical Sciences. • Empower every individual to develop as a professional with an ability to apply his/her knowledge and skills to adapt to the evolving technological requirements of society.

PROGRAMEDUCATIONAL OBJECTIVES (PEOs)

The PEOs have been evolved in alignment with the vision and mission of the Department. The broad objective of the program is to facilitate the development of competent and successful professionals in tune with modern day technological and societal requirements.
Therefore, after concerted interactions (both formal and informal) with all major constituents including Alumni, Employers, experts from industry and institutions, faculty and students, parents etc., the following Program Educational Objectives of the UG course offered by Electrical and Electronics Engineering department have been arrived at:

The PEOs of the program are as under:

1. **PEO-1:**Possess successful careers in Electrical Sciences, and allied areas and pursue higher education with a broad knowledge base in Mathematics and Engineering principles.

2. **PEO-2:**Utilize their technical, analytical, communicative and managerial skills and knowledge for societal progress and enrich them to keep in pace with relevant advancements by engaging themselves in lifelong learning.

3. **PEO-3:** Exhibit professionalism by displaying competence, leadership, dedication and commitment.

Program Outcomes

Program outcomes (POs), are attributes acquired by the students at the time of graduation. The POs given in the table below, ensure that the POs are aligned to the Graduate Attributes (GAs) specified by National Board of Accreditation (NBA). These attributes are measured at the time of graduation and hence computed every year for outgoing batch. The POs are addressed and attained through the Course Outcomes (COs) of various courses of the curriculum.

MAPPING OF COURSES TO PROGRAM OUTCOMES

Program Outcomes		Courses
PO-1	Apply the knowledge of mathematics, science, and engineering principles to the solution of electrical and allied engineering problems.	Basic Electrical Engg, Linear Circuit analysis, Field Theory , Signals and Systems, Digital Signal Processing, Modern Control Theory
PO-2	Formulate and analyze complex engineering problems using first principles of mathematics, physical and engineering sciences.	Linear Circuit analysis, Field Theory ,Signals and Systems, Digital Signal Processing, Modern Control Theory, EES, TND
PO-3	Design solutions for complex engineering problems, and design system components that meet specific societal needs.	DSP,Microcontrollers,Power Systems I & II,Power Electronics I & II, E1&2,Switch Gear Protection, EES
PO-4	Design and conduct experiments and analyze and interpret data for complex systems.	EES,PS1,PS2,AME,DE,AIC,MC,DSP,MC1&2,MCT
PO-5	Select and apply appropriate modern engineering tools to complex engineering activities with an understanding of the limitations.	SIM LAB1,SIM LAB2,MC1&2,PS1&2,PE1&2 MCT,MC,DSP
PO-6	Apply reasoning informed by contextual knowledge to assess societal health, safety, legal and consequent responsibilities relevant tothe professional engineering practice.	Professional Practices In Electrical Tech,TND
PO-7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	EES, Professional Practices in Electrical Tech
PO-8	Understand ethical principles and	Professional Practices in Electrical Tech,

	social issues.	Professional Ethics ,EES
PO-9	Function effectively as an individual, and as a member or leader in diverse teams to accomplish a common goal.	Projects, Self-study
PO-10	Communicate effectively with diverse audiences and able to write effective reports and design documentation.	Seminars,Projects,Self-study
PO-11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects in multi-disciplinary environments.	Project Management,Projects
PO-12	Recognize the need to engage in independent and lifelong learning in the context of technological change.	Self-Study Component, Participation In Extension Lectures,Value Added Courses, Workshops.

PROGRAM SPECIFIC OUTCOMES

The students will have the ability to:

PSO1:Develop models, analyze and assess the performance of different types of generation, transmission, distribution and protection mechanisms in power systems**.**

PSO2: Design, develop, analyze and test electrical and electronics systems; deploy control strategies for power electronics related and other applications.

PSO3: Measure, analyze, model and control the behavior of electrical quantities associated with constituents of energy or allied systems.

MAPPING OF COURSES TO PROGRAM SPECIFIC OUTCOMES

PSO	Courses
PSO1: Develop models, analyze and assess the performance of different types of generation, transmission distribution and protection mechanisms in power systems.	Transmission and Distribution Electrical Energy Systems Power systems 1 Power systems 2 Switchgear and Protection
PSO2: Design, develop, analyze and test electrical and electronics systems; deploy control strategies for power electronics related and other applications.	Machines-I & II, Power Electronics-I &II+Lab+SS Microcontrollers+Lab+SS Signals and Systems Analog Micro Electronics+Lab+SS Digital Electronics +Lab+SS
PSO3: Measure, analyze, model and control the behavior of electrical quantities associated with constituents of energy or allied systems.	Analog integrated circuits + Lab+SS Linear circuit analysis Digital Signal Processing + Lab + SS Field Theory Control systems Modern control theory Controls and Measurements Lab Simulation Lab I & II

CREDIT SUMMARY

2014-2018 Batch

Sem	HSS	BSC	ESC	PCC		PEC		IEC	Project	Seminar/ Internship	Total
				DC	GC	DE	CE				
I	02	10	13	-		-		-	-	-	**25**
II	03	09	13	-		-		-	-	-	**25**
III	-	04	-	01	20	-		-	-	-	**25**
IV	-	04		01	20	-		-	-	-	**25**
V	-	-	-	22		03		-	-	-	**25**
VI	-	-	-	19		03	03	-	-	-	**25**
VII	-	-	-	12		03	03	03	04	-	**25**
VIII	04	-	-	03	03			03	10	02	**25**
Total	**09**	**27**	**26**	**58**	**43**	**09**	**06**	**06**	**14**	**02**	**200**

V Semester Scheme

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16EE5DCTND	Transmission and Distribution	3	0	0	0	3
2	16EE5DCMC1	Electric Machines – I	3	0	1	2	6
3	16EE5DCENS	Electrical Energy Systems	3	0	0	0	3
4	16EE5DCDSP	Digital Signal Processing	3	0	1	2	6
5	16EE5DCMNI	Measurements and Instrumentation	3	0	0	0	3
6	16EE5DE1XX	Department Elective I	3	0	0	0	3
7	16EE5DCMCL	Measurements and Controls Lab	0	0	1	0	1
Total			18	0	3	4	25

VI Semester Scheme

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16EE6DCPS1	Power Systems – I	3	1	0	0	04
2	16EE6DCMC2	Electric Machines – II	3	0	1	2	06
3	16EE6DCPE1	Power Electronics-I	3	0	1	2	06
4	16EE6DCMCT	Modern Control Theory	2	1	0	0	03
5	16EE6DE2XX	Department Elective-II	3	0	0	0	03
6	16XX6GE1XX	Cluster Elective – I	3	0	0	0	03
Total			17	2	2	4	25

VII Semester Scheme

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16EE7DCPS2	Power System – II	3	1	0	0	4
2	16EE7DCSGP	Switchgear and Protection	3	0	1	0	4
3	16EE7DCPE2	Power Electronics-II	3	0	1	0	4
4	16EE7DEXXX	Department Elective – II	3	0	0	0	3
5	16XX7GE2XX	Cluster Elective – II	3	0	0	0	3
6	16XX7IE1XX	Institutional Elective – I	3	0	0	0	3
7	16EE7ESPW1	Project - I	0	0	4	0	4
Total			**18**	**1**	**6**	**0**	**25**

VIII Semester Scheme

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16EE8DCPET	Professional Practices in Electrical Engineering Technology	1	0	0	2	3
2	16XX8IE2XX	Institutional Elective	3	0	0	0	3
3	16EE8GCPMF	Project Management and Finance	1	0	0	2	3
4	16HSXGEXXX	HSS Elective Course/ NSS/NCC/Yoga/Sports/Foreign Language/ Performing Arts	0	0	2	0	2
5	16EE8ESPW2	Project-II	0	0	10	0	10
6	16HSXGCXXX	Soft Skills (Placement training)	0	0	2	0	2
7	16EEXGCXXX	Internship/Industrial Training/Technical Seminar/Minor Project	0	0	2	0	2
Total			**5**	**0**	**16**	**4**	**25**

Department Elective -I

Sl. No	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16EE5DE1ES	Embedded System Design	3	0	0	0	3
2	16EE5DE1HD	Design and implementation of Digital Systems using HDL	2	0	1	0	3
3	16EE5DE1CP	C++ for Engineering Applications	2	0	1	0	3
4	16EE5DE1TC	Electrical Installation, Testing, Commissioning and Maintenance	3	0	0	0	3
Total			10	0	2	0	12

Department Elective- II

Sl. No	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16EE6DE2UP	Utilization of Electrical Power	3	0	0	0	3
2	16EE6DE2CV	Circuit Design using VLSI	3	0	0	0	3
3	16EE6DE2CS	Communication Systems	3	0	0	0	3
4	16EE6DE2MD	Electric Machine Design	3	0	0	0	3
Total			12	0	0	0	12

Department Elective- III

Sl. No	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16EE7DE3HV	HV Engineering	2	0	1	0	3
2	16EE7DE3CN	Computer Communication and Networking	3	0	0	0	3
3	16EE7DE3DP	DSP applications to Power Engineering	3	0	0	0	3
4	16EE7DE3ID	Industrial Drives	3	0	0	0	3
Total			11	0	1	0	12

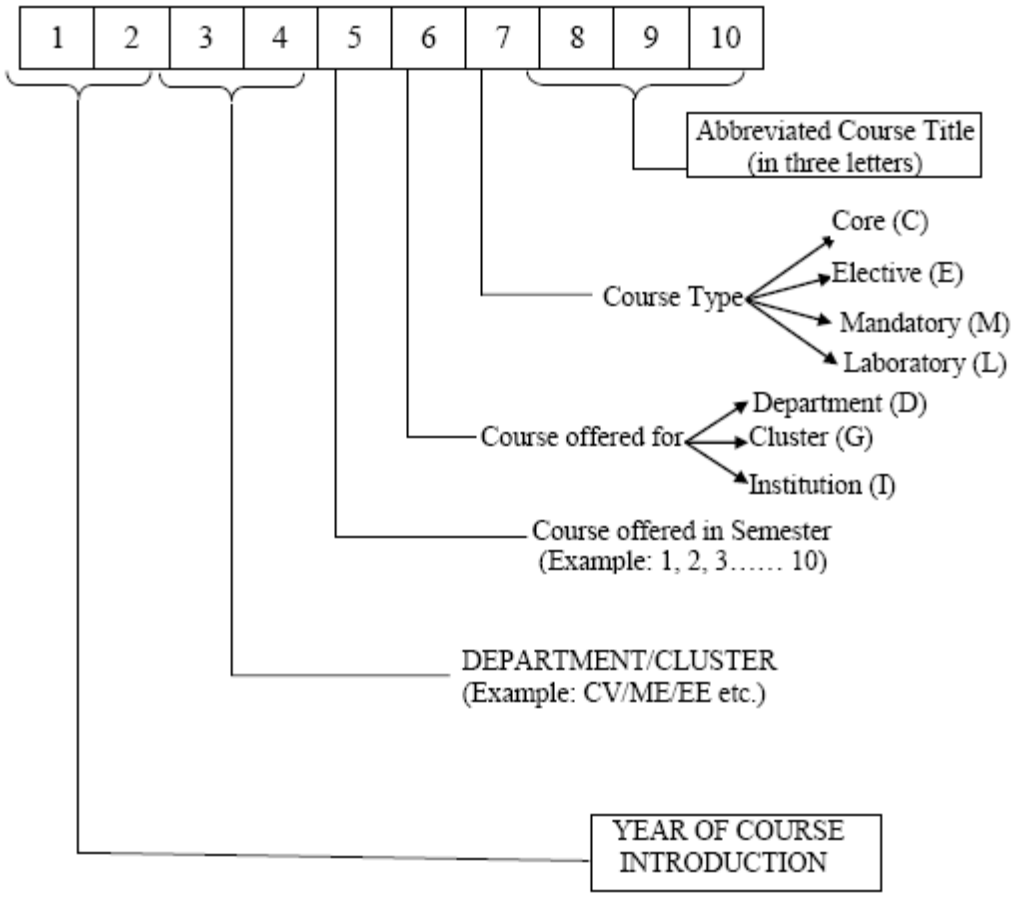
Cluster Elective-I (Programs: EC/TC/IT/EE/ML)

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16EE6GE1EM	Electrical & Electronic Engineering Materials	3	0	0	0	3
2	16EE6GE1EC	Electromagnetic Compatibility (Except EC and IT)	3	0	0	0	3
3	16EE6GE1CT	Modern Control Theory (Except EE)	3	0	0	0	3
Total			9	0	0	0	9

Cluster Elective-II (Programs:EC/TC/IT/EE/ML)

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16ES7GE2PQ	Electrical Power Quality	3	0	0	0	3
2	16ES7GE2RE	Renewable Energy Technologies	3	0	0	0	3
3	16ES7GE2PL	PLC and SCADA (Offered by EE and IT)	3	0	0	0	3
Total			9	0	0	0	9

NOMENCLATURE FOR THE COURSE CODE



V Semester Syllabus

Course Title	TRANSMISSION AND DISTRIBUTION				
Course Code	16EE5DCTND	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks (100% weightage)	SEE	100 Marks(50% weightage)		

Pre-requisites:

Knowledge of Basic Electrical Engineering, Field Theory

Course Description:

This course discusses insulators used for the overhead lines along with the string efficiency and methods to improve it, mechanical design of transmission lines including the sag and tension calculations, wind and ice loadings, insulated cables including the grading and calculation of capacitances in single core and three core cables, The fundamental concepts and detailed calculations of line parameters such as inductances and capacitances, performance analysis of the overhead lines with different equivalent models used for the calculation of regulation and efficiency, types of distributors and grounding system.

UNIT-I		9 hours

Typical Transmission & Distribution systems scheme- Standard voltages for generation, transmission and distribution. Advantages of high voltage transmission. Feeders, distributors &service mains. Mechanical design of Transmission Lines- Types of conductors, conductor materials , Calculation of sag in conductors i) At equal supports ii) At different level supports. Effect of ice covering and wind pressure, factors affecting sag. Overhead Line Insulators-Types of insulators, potential distribution over a string of suspension insulators. String efficiency & methods of improving string efficiency.

UNIT-II		7 hours

Underground cables- General construction of a cable, types of cables, material used, expression for insulation resistance, dielectric stress, power factor, capacitance, charging current of a single core power cable, grading of cables, capacitance grading & inter sheath grading, measurement of capacitance of a three core cable, determination of maximum current carrying capacity of cables.

UNIT-III		8 hours

Line parameters-Calculation of inductance of single phase, 3 phase line with equilateral & unsymmetrical spacing (transposed), calculation of capacitance of a single phase line, 3 phase line with symmetrical and unsymmetrical spacing (transposed) without considering the effect of

earth on transmission line capacitance.

UNIT-IV		**8 hours**

Performance of power transmission lines- Classification of lines, Short Transmission lines, medium Transmission lines - nominal T method, nominal π method and long transmission lines – Rigorous solution method, ABCD constants of Transmission lines, calculation of voltage regulation and transmission efficiency.

UNIT-V		**7 hours**

Distribution systems- Classification, radial distribution systems, ring distribution system, DC distribution system with concentrated loads and uniform loading, AC distribution.
Earthing -Basic terms of earthing, methods of neutral grounding.

Text books:

1	Electrical Power Transmission and Distribution- S.Sivanagarajuand S.Satyanarayana, Pearson Education.
2	Transmission and Distribution of Electrical Power - J.B.Gupta, S.K.Kataria and sons.

Reference books:

1	Elements of Power System Analysis- W.D. Stevenson, Mc.Graw - Hill. Comp.Ltd.
2	Electric power generation Transmission & Distribution- Dr. S. N. Singh, PHI learning Ltd, New Delhi, 2nd Edition.
3	Electrical Power Systems- C.L.Wadhwa, New Age International publishers, 6th Edition.

E Books:

1	NPTEL courses in Electrical Engineering :Power system generation, Transmission& distribution: Video Lecture Numbers:10,11,12,13,18,19,20,23 by Prof .D. P. Kothari, Centre for Energy Studies ,IIT New Delhi.

Course outcomes At the end of the course, the student will have the ability to
CO1: Select a suitable insulator & design the transmission line for the required sag.
CO2: Develop mathematical models of the transmission line with different configurations and determine the parameters
CO3: Develop network models of different types of transmission lines and assess their performance.
CO4: Analyze and distinguish different distribution system topologies, underground cable grading and earthing types and their basis for selection.

Course Title	ELECTRICAL MACHINES I				
Course Code	16EE5DCMC1	Credits	6	L-T-P-S	3-0-1-2
CIE	50 Marks (100% weightage)	SEE	100 Marks(50% weightage)		

Pre-requisites:
Electromagnetism, Fundamentals of single phase and three phase ac circuits, basic concepts and operation of Transformers and Three phase Induction motors.

Course Description:

This course provides a basic understanding of AC machinery fundamentals,constructional features,operational analysis through phasor diagrams, equivalent circuits,determination of performance parameters, testing and applications.

UNIT-I		8 hours

Transformers

Single Phase Transformers: Ideal transformer- on No Load, on load,{Voltage Current ratios and Vector diagram}, Resistance and leakage reactance, Practical transformer - vector diagram of practical transformer on load, Lumped parameters, Equivalent Circuit model of a transformer-Approximate and simplified, Efficiency and Voltage regulation, Predetermination of efficiency, Voltage regulation and equivalent circuit analysis of single phase transformers by O.C and S.C. test, Sumpner's test.

Parallel operation of two single phase transformers and load sharing, Auto transformer. Output Equation of single phase transformers, area of iron and copper, number of turns

UNIT-II		8 hours

Three Phase Transformers and Fundamentals of rotating AC machines

a) Three Phase Transformers - Three phase transformer connections – star-star, star-delta, delta-star, delta-delta, open delta (V-V), choice of three phase transformer connection, Scott connection-3 phase to 2phase and vice-versa.

b) AC armature windings -Terminology and Types, Winding factors, EMF generated, MMF distribution, slot harmonics, Concept of rotating magnetic field (Mathematical proof) in poly phase AC machines, Production of torque- electromagnetic and reluctance torque.

UNIT-III		9 hours

Three phase Induction Motor - Principle of operation-slip, frequency of rotor current/EMF, speed of rotor field, rotor EMF, rotor current and power factor. Rotor Torque - Expression for

rotor torque, starting torque, Full load torque, pull out torque, Torque - slip curve, Factors affecting rotor torque and slip.

Losses and power flow in three phase Induction motor- rotor output and motor torque, synchronous watt. Equivalent circuit model - Electrical equivalent of mechanical load, relation between rotor input and rotor cu-loss, Phasor diagram of three phase Induction motor. Comparison of three phases IM and Transformer.

Main dimensions of three phase IM, Separation of D and L, Length of air gap

UNIT-IV		**9 hours**

Tests on Three Phases IM- Stator resistance test, no load test, voltage ratio test, Blocked rotor test, Heat run test. Measurement of slip – Stroboscopic method, Circle diagram – construction and predetermination of performance (efficiency, slip , torque, power factor, current, at any given load and at maximum conditions), factors affecting performance of three phase Induction motor, cogging and crawling. High torque cage motors – Deep bar cage rotor motor, double cage rotor motor. Applications of three phase Induction motor, Induction Generator.

UNIT-V		**5 hours**

Fractional HP AC motors

Introduction to single phase Induction motors, construction – stator, rotor and windings, Working principle, Double revolving field theory, Equivalent circuit of single phase Induction motor, Starting methods - Split – phase, shaded pole type, applications, Universal motor, Repulsion motor.

Laboratory Experiments :

OC and SC test on single phase transformer, Direct load test on single phase transformer, Parallel operation of two dissimilar single phase transformers, Sumpner's test, Three phase connection of three single phase transformers, Scott connection for balanced and unbalanced two phase upf loads, Load test on single phase induction motor, No Load and blocked rotor test on three phase induction motor, Speed control of three phase induction motor – Rotor resistance control

Text books:

1	Theory and performance of Electrical Machines- J.B. Gupta, S.K. Kataria and sons-New

	Delhi.
2	Electrical Machinery,Dr. P.S. Bhimbra, , Khanna Publications, 7th Edition, 2007.
Reference books:	
1	Electric Machines – Ashfaq Husain, Dhanpatrai and Co. , Second Edition.
2	Performance and Design of Alternating Current Machines,M. G. Say, John Wiley and Sons Publications, 3 rd Edition
3	A Course in Electrical machine design, A. K. Sawhney, DhanpatRai and Sons
E Books:	
1	http://nptel.ac.in/courses/108105017/
2	http://nptel.ac.in/courses/108106072/
Course Outcomes: At the end of the course, the student will have the ability to	
CO1: Sketch and describe the constructional details and operating principles of Transformers and Induction Motors.	
CO2: Analyze the performance of Transformers and Induction Motors using phasor diagrams and circuit model of machines	
CO3: Select appropriate AC machine for a specified application and justify the selection.	

Course Title	ELECTRICAL ENERGY SYSTEMS				
Course Code	16EE5DCENS	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Basic Electrical Engineering

Course Description:

This course focuses on the current energy scenario in the country and the role of conventional & non –conventional energy sources. The operation of different conventional power plants, working of solar photovoltaic and wind energy systems and their importance, types of cost structure and hence tariff for power generation are dealt with. The necessity of power factor improvement to reduce load, plant capacity and cost of power are covered. Types of substation and bus bar arrangement schemes for power transmission and their location, environmental impact and viability issues are also addressed.

UNIT-1		5 hours

Sources of Electrical Power

Conventional and nonconventional sources-Introduction, world energy futures, Energy sources and their availability, Energy scenario in India, Combined heat and power distributed generation.

UNIT-2		12 hours

Detailed study of conventional sources

Selection of site, classification, general arrangement and operation of Hydro thermal and Nuclear power stations.,

UNIT-3		7 hours

Non-conventional sources

Solar electric Power Generation: Solar photovoltaics, solar cell principles, Conversion efficiency and power output, Basic photovoltaic system for power generation, solar photovoltaic

arrays and connecting arrangements Wind: Basic principle of wind energy conversion systems and components, nature of wind, wind survey in India. Introduction to Bio mass conversion. Introduction to micro hydel systems.

UNIT-4		**8 hours**

Economic aspects

Introduction, terms commonly used in system operation. Diversity factor, load factor, plant capacity factor, plant use factor, load duration curve. Power factor improvement and tariffs. Energy-load curve.

UNIT-5		**7 hours**

Substations

Introduction, types, Bus bar arrangement schemes, location, Substation equipment. Reactors and capacitors Current limiting reactors.

Energy and Environment- Environmental impact of power plants and social issues of concern - Sulfur oxides, nitrogen oxides, ozone, acid rain, ashes, carbon dioxide, radioactive releases Introduction to smart grid: Major difference between conventional and smart grid. Energy efficiency of various conventional and non – conventional conversion systems.

Text books:

1	Power System Engineering, A. Chakrabarti, M. L. Soni, and P.V. Gupta, U.S. Bhatnagar, DhanpatRai and Co., New Delhi. (T1)
2	Non-conventional Energy Sources**,** G D Rai, Khanna Publishers (T2)

Reference books:

1	Electrical Engineering: An introduction, El – Sharkawi, CRC Press.(R1)
2	Electric Power Generation, Transmission and Distribution**,** Dr. S. N. Singh, P.H.I., New Delhi.(R2)
3	Electrical Power Generation**,** Prof.B.N.Yoganarasimhan (R3)

E Resources:

1.	https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&ved=0ahUKEwjf2IXfwfTMAhUGr48KHQY4D2UQFggvMAM&url=http%3A%2F%2Fwww.theiet.org%2Ffactfiles%2Fenergy%2Fsmart-grids-page.cfm%3Ftype%3Dpdf&usg=AFQjCNE7w-9jRar-0rDoUDIxfs07KbWWvw&bvm=bv.122676328,d.c2I

2.	https://beeindia.gov.in/sites/default/files/1Ch1.pdf

Course outcomes At the end of the course,the student will have the ability to
CO1:Interpret the data available on the nation's energy scenario, distinguish the contributions of conventional and non-conventional sources and co-generation units in power plants.
CO2:Describe the operation of different kinds of conventional and non-conventional energy resources and assess their environmental impact and viability in different social situations
CO3:Evaluate various factors that contribute to the economic operation and efficient management of Energy systems.
CO4:Compare, choose amongst the various types of substations for a specified location and justify.

Course Title	DIGITAL SIGNAL PROCESSING (EE only)				
Course Code	16EE5DCDSP	Credits	06	L-T-P-S	3-0-1-2
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Signals and Systems, Electric Circuit Analysis, Control systems

Course Description:

The course covers topics on various analysis of discrete-time signals in the frequency domain, design and realization of finite impulse response and infinite impulse response digital filters, basics of multi-rate signal processing, application of processing techniques to audio,ecg, speech and electrical signals.The laboratory experiments are closely coordinated with each unit.

UNIT-I		7 hours

Introduction to DSP, Signal Sampling and reconstruction: Practical considerations, Discrete Fourier Transform(DFT) Formulae, Useful properties of DFT:Linearity, Circular shift, Multiplication by a complex exponential sequence, properties of even and odd parts of x[n]. Multiplication,Parseval'srelation, Circular convolution in the time domain, use of tabular arrays &circular arrays.

UNIT-II		8hours

Use of DFT in Linear filtering, Linear convolution of two finite duration sequences, overlap add and save methods,Relation between DFT and other transforms, Radix 2 Fast Fourier Transform(FFT) algorithm for DFT computation, decimation in time algorithm, Decimation in Frequency algorithms.Computational efficiency, Radix 2 FFT algorithm for computation of Inverse Discrete Fourier transform (IDFT),Signal Spectrum: Computation of Amplitude,Phase and Power Spectrum.

UNIT-III		10hours

Basic types of filtering ,Realization of Digital Filters: Direct Form-I,Direct Form-II, Cascade and Parallel representation, realization of Infinite Impulse Response (IIR) systems: Direct form ,Parallel form, Cascade form, Introduction to IIR filters, Pole zero placement method for simple IIR Filters,Second order band pass and band stop,First order low pass, high pass filter designs, Transformation Design Method: Analog Filters using low pass prototype

transformation,Frequency Warping, Design procedure. Digital Butterworth Filter design.

UNIT-IV		**8 hours**

Realization of Finite Impulse Response (FIR)systems

Transversal form, Linear Phase Form, Introduction To FIR filters, Design of FIR by Window method: Rectangular, Triangular, Hanning, Frequency sampling design method.

UNIT-V		**6 hours**

Multirate signal processing basics, application of filters in heart rate detection using electro cardiography, speech noise reduction, processing for various measurements in power systems.

Lab Experiments:

Study of various types of discrete time signals and analysis of the sampling effect in their processing, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) algorithms for computation of DFT, Frequency domain analysis: Verification of DFT properties, determination of power and phase spectrum of signals, Implementation of various operations such as circular convolution, block convolution,multi-rate signal processing on discrete time signals. Design and implementation of digital filters.

Text books:

1	Digital signal Processing- Fundamentals and Applications, Li Tan, Published by Reed Elsevier, India Private Limited, New Delhi-110065,2008.
2	Digital Signal Processing – Principles, Algorithms & Applications, John G. Proakis & Dimitris G.Manolakis, Pearson education / Prentice Hall,Fourthedition, 2007.

Reference books:

1	Fundamentals of Digital Signal Processing, Lonnie C. Ludeman,Jon Wiley & Sons,1987.
2	Discrete Time Signal Processing, Pearson Education, Alan V.Oppenheim, Ronald W. Schafer &Hohn. R.Back2nd edition, 2005.
3	Power Systems Signal Processing for Smart Grids,Paulo Fernando Ribeiro, Carlos Augusto Duque, Paulo MarcioRibeiro, Augusto Santiago Cerqueira,Wiley, December 2013.

E Books:	
1	The Scientist and Engineer's Guide to Digital Signal Processing By Steven W. Smith, Ph.D.
2	Digital Signal Processing Principles, Algorithms, and Applications John G. Proakis Northeastern University Dimitris G. Manolakis, Third Edition
MOOCS:	
1	https://www.mooc-list.com/course/applied-digital-signal-processing-dit?static=true
2	Sign up at http://www.coursera.org/course/dsp

Course Outcomes:

At the end of the course ,the student will have the ability to

CO1: Apply Discrete Fourier transforms for different types of signals, interpret the information obtained and reconstruct.

CO2: Analyze discrete parameter signals and their transforms for their behaviour.

CO3: Design and demonstrate application of linear system analysis to engineering problems.

Course Title	MEASUREMENTS AND INSTRUMENTATION				
Course Code	16EE5DCMNI	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Basic Electrical Engineering

Course Description:

This course covers description of different types of bridges used for measurement of resistance, inductance & capacitance, instruments used for the measurement of power, power factor, energy & frequency, instrument transformers used in ac measurement, construction,operation& applications of Crompton's DC potentiometer, operation of digital voltmeters &types of waveform generators, selection of transducers based on the application.

UNIT-I		8 hours

Measurement of Resistance -Wheatstone's bridge, sensitivity, limitations, Kelvin's double bridge, Fall of potential method. Measurement of inductance &capacitance , Sources& detectors, Maxwell's inductance bridge, Maxwell LC bridge, Anderson's bridge, Desauty's bridge, Schering bridge, Errors in AC bridges & methods of minimization.

UNIT-II		8hours

Measurement of Power, Energy, Power factor & Frequency meter - Review of construction & operation of Dynamo meter wattmeter & Induction type energy meter, errors in wattmeter,LPF wattmeter, errors & adjustments in single phase energy meter, construction & operation of single phase dynamometer type power factor meter ,Weston frequency meter.

UNIT-III		7 hours

Extension of instrument ranges - Construction & theory of instrument transformers, expression for ratio error & phase angle error in CT, causes of errors & means to reduce errors in CT.
DC Potentiometer: Construction & operation of Crompton's type dc potentiometer,Applications of dc potentiometer.

UNIT-IV		8 hours
Electronic instruments - Block diagram & working of Ramp type DVM, Integrating type DVM,Servo balancing type DVM, AF Sine & square wave generator, Function generator, Field strength meter.		
UNIT-V		**8 hours**
Transducers - Classification of transducers, selection factors, operation of Potentiometric Transducer, LVDT, Strain gauges, Temperature transducers, Piezoelectric transducer.		

Text books:	
1	Electronic instrumentation-H.S.Kalsi, TMH Education Private limited, New –Delhi. 3rd edition,
2	A Course in Electrical & Electronic measurements & instrumentation-A.K.Sawhney, DhanpatRai& Co(Pvt) limited, New –Delhi.Nineteenth revised edition 2011,
Reference books:	
1	Modern Electronic instrumentation & measurement Techniques-William.D. Cooper& A.D.Helfrick, Pearson Education. First edition 2015,
2	Electronic instrumentation & measurements-David.A.Bell**,** Oxford University. 3rd edition 2013
E Books:	
1	http://www.free-engineering-books.com/2013/05/electronic-instrumentation-and.html.

Course outcomes
At the end of the course, the student will have the ability to
CO1: Identify& select suitable bridges for the measurement of electrical circuit parameters.
CO2: Distinguish the concept behind the operation of analog & digital instruments for the measurement of electrical circuit parameters.
CO3: Select and justify the choice of asuitable transducerfor an application.

Course Title	Measurements and control systems Lab				
Course Code	16EE5DCMCL	Credits	01	L-T-P-S	0-0-1-0
CIE	50 Marks (100%weightage)	SEE	50 Marks(50% weightage)		

Part A Experiments	
1.	To Measure (a) Medium resistance by Wheatstone bridge (b) Low resistance by Kelvin's Double Bridge (c) High Resistance by Megger
2.	Measurement of Inductance and Capacitance by (a) A-V-W Method (b) Three Voltmeter Method.
3.	Measurement of Inductance and Capacitance using A.C Bridges.
4.	To measure the variation in speed of a dc servomotor in terms of voltage and frequency using an optical sensor and a frequency to voltage converter.
5	Using Matlab/Simulink create transfer functions, state space models, change from state space to transfer function models and vice versa, Build systems with unity and non unity feedback and obtain their step response
6.	Computing poles and zeros of a system described by higher order polynomialsand vice versa,visualize the effect of changes in poles and zeros of a transfer function on the system response, mesh plots.Comparison of step and impulse responses of systems.
7.	Create and analyze root locus plots. Design by means of root locus plots.
8.	Simulation of PID control using Simulink and experimental verification on a second order system.
9.	Design a passive RC lag compensating network for the given specifications,viz, the maximum phase lag and the frequency at which it occurs and to obtain its frequency response.Verify experimentally the frequency response of the above lag compensating network.
10.	Design a passive RC leadcompensating network for the given specifications,viz,the maximum phase lead and the frequency at which it occurs and to obtain its frequency response.Verify experimentally the frequency response of the above leadcompensating network.

Course Title	EMBEDDED SYSTEM DESIGN (Department Elective I)				
Course Code	16EE5DE1ES	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Microcontrollers

Course Description:

The course gives an insight to the fundamental concepts related to hardware and software designing of embedded systems inculcating the salient topics such as processor and memory organisation along with case studies, real time operating systems (RTOS), an overview of the various scheduling algorithms, peripheral interfacing . The latter part comprises introduction, architecture and basic assembly level programming of PIC microcontroller, Timers, Interrupts handling, ADC and DAC using PWM.

UNIT-I		7 hours

Concept Of Embedded System Design - Definition, internal block diagram and components, classification, skills required,Embedded software in a system, design process in embedded systems, design metrics, challenges in Embedded system design. Examples of embedded systems: Automatic chocolate vending machine and smart card.

UNIT-II		7hours

Processor and Memory Organization - Processor and memory organization, Princeton and Harvard architecture, Instruction –Level parallelism: pipelined and superscalar units, Memory types, memory maps and addresses, processor selection and Memory selection (including two case studies for each)

UNIT-III		9hours

Real Time Operating System(RTOS) And Scheduling Algorithms

Introduction to RTOS, fundamental requirements of RTOS, real time kernel types, schedulers, various scheduling algorithms with examples, latency (interrupt latency, scheduling latency and context switching latency), tasks, state transition diagram, task control block. Inter-task communication and synchronization of tasks.

UNIT-IV		7 hours

Devices And Peripheral Interfacing - I/O types and examples, serial communication devices, parallel device ports, parallel port interfacing with switches, keypad,stepper motor, Timer and counting devices, Watch dog timer.

UNIT-V		9hours
Microchip PIC Microcontroller - Introduction to PIC Microcontroller - 16Fxx series, CPU Architecture, Addressing modes, Instruction set, Basic assembly level programming, Timers, Interrupts, ADC,DAC using PWM.		
Text books:		
1	Rajkamal Embedded System Architecture: Programming & Design, TMH Edition, 2007.	
2	John B. Peatman Design with PIC Microcontrollers, Prentice Hall, 1997.	
Reference books:		
1	J. W. Valvano Embedded Microcomputer System: Real time interfacing, Cengage-Engineering, 1st Edition, 2000.	
2	Jane W.S. Liu,Real Time Systems, Prentice Hall, 2000.	
E Resourses:		
1	http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Embedded%20systems/New_index1.html	
2	http://nptel.ac.in/courses/108102045/	

Course outcomes At the end of the course ,the student will have the ability to
CO1: Design an embedded system as solution to real time problems applying the knowledge of processor, memory and peripheral interfacing techniques.
CO2: Analyze schedulers, scheduling algorithms, latencies, task, and synchronization of tasks for real time embedded systems.
CO3: Realize a RISC Microcontroller and apply the knowledge of programming to develop small scale embedded applications.

Course Title	Design and Implementation of Digital Systems using HDL (Department Elective I)				
Course Code	16EE5DE1HD	Credits	03	L-T-P-S	2-0-1-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Digital Electronics

Course Description:

This course deals with the study of programming language for the design and implementation of the Digital Electronic systems. Two major styles, namely, VHDL and Verilog are dealt with.

UNIT-I		4 hours

Introduction: Why HDL, Structure of HDL Module, Operators, Data types, Brief comparison of VHDL and Verilog.

UNIT-II		7 hours

Data – Flow Descriptions: Highlights of Data – Flow Description, Structure of Data – Flow Description, Data Type – Vectors. Dataflow descriptions (Both VHDL & Verilog) of Half adder, 2*1 MUX, 2*2 unsigned array multiplier, D-Latch, 2-Bit magnitude comparator, 3 – Bit ripple carry adder & carry look ahead adder.

Behavioral Descriptions: Behavioral Description highlights, Structure of HDL behavioral Description, VHDL variable – assignment statement, sequential statements. Behavioral descriptions (VHDL & Verilog) of 2*1 MUX, D-Latch, Edge triggered JK Flip flop, 3-Bit Binary counter, Booth Algorithm.

UNIT-III		6 hours

Structural Descriptions: Highlights of structural Description, Organization of the structural Description, Binding, Generate, Generic and parameter statements. Structural Descriptions (VHDL & Verilog) of Half Adder, 2*1 MUX, 2*4 Decoder, Full adder, SR-Latch, Master Slave D – Flip flop & JK – Flip flop. Application of structural description to implement SRAM Cell.

N – Bit Magnitude comparator & N-Bit Asynchronous down counter using Generate statements.

UNIT-IV		**5 hours**

Procedures, Tasks and Functions: Highlights, Procedures and tasks, Functions.HDL Description of Full adder, N-Bit Ripple Carry adder, data type conversions using Procedures and tasks, Functions to find Greater of two numbers.

UNIT-V		**4 hours**

Synthesis Basics: Highlights of Synthesis, Synthesis information from Entity and Module, Mapping Process and Always in the Hardware domain

Applications: Interfacing programs –Seven Segment Display, Waveform generation: ramp, square, triangular.

Lab Experiments:

VHDL & Verilog programs to realize the following using Xilinx ISE Design Suite software:

Basic gates, Half & Full adder, Half & Full subtractor, Binary to Gray code conversion.,4:1 MUX, 2:4 Decoder, 2*2 Combinational array multiplier, Priority Encoder, D-Flip flop, JK – Flip flop,Booth Algorithm, 3 – Bit Binary up counter & down counter ,Interfacing programs.

Text books:

1	"HDL Programming - VHDL and Verilog", Nazeih M Botros, Dreamtech Press, 2006 Edition, reprint 2009.

Reference books:

1	"Verilog HDL – A Guide to Digital Design and Synthesis",Samir Palnitkar, Pearson Education, Second Edition.
2	"VHDL – Programming by example", Douglas Perry, TMH, Fourth Edition.
3	"Circuit Design with VHDL",Volnei A Pedroni, PHI, Second Edition.

Course outcomes

At the end of the course,the student will have the ability to

CO1: Apply digital electronics engineering fundamentals to identify, formulate and analyse various digital systems.

CO2: Design hardware/software systems using appropriate modelling techniques within certain constraints such as cost.
CO3: Test and interpret the data through experiments using modern IT tools.

Course Title	C++ for Engineering Applications (Department elective I)				
Course Code	16EE5DE1CP	Credits	3	L-T-P-S	2-0-1-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Basic principles of programming concepts

Course Description:

The course deals with applying the concepts of OOPs to C++ as an example language. The course gives introduction to basic concepts of C++ programming (including data types, operators, selections, loops, functions and simple I/O syntax), Advanced topics such as classes, objects, data abstraction, data encapsulation, overloading, inheritance, polymorphism and reusability, templates, exceptions and file handling concepts are also dealt with. Application of programming in C++ for realization of digital circuits, steady state and transient analysis of electrical networks are covered.

UNIT-I		5 hours

Principles Of Object Oriented Programming - Basic Concepts of OOPS, OOP Languages, Pre-processors directives and header files, Beginning with C++: Definition , structure of C++ program, compiling and linking, Tokens, expressions and control Structures: Tokens, keywords, identifiers and constants, datatypes, symbolic constants, variables, operators, manipulators, control and statement loops.

UNIT-II		5 hours

Functions In C++: Introduction, Main function, function prototype,call by reference,return by reference, inline functions, function overloading, friend and virtual functions.

Classes and objects: Specifying a class, memberfunctions, arrays within a class,static data members and member functions, arrays of objects, returning objects

UNIT-III		**5hours**

Constructors And Destructors - Constructors, parameterized constructors, multiple constructors in a class, copy constructor, dynamic constructors and destructors.Operator overloading and type conversions: Overloading unary and binary operators, overloading using friends, rules of overloading.

UNIT-IV		**5 hours**

Inheritance - Introduction, defining derived classes, Types of inheritance: Single, multilevel, multiple, hierarchical, hybrid.Pointers,virtual and polymorphism: Pointers,pointers to objects,this pointer, pointers to derived classes,virtual functions.

Managing console I/O operations:C++ streams,C++ stream classes, unformatted and formatted I/O operations.

UNIT-V		**6 hours**

Templates And File Handling

Templates: Class templates, Function templates

Exception handling: Basics, Throwing and catching mechanisms, rethrowing an exception.

File operations: Introduction, classes for file stream operations, Opening and closing afile:opening files using constructors, detecting end-of-file.

C++ for Electrical and Electronics engineering concepts –

C++ programming for digital circuits, AC circuits, steady state and transient analysis of electrical networks.

Lab Experiments:

CPP programs based on operators,manipulators,control and statement loops, CPP programs based on functions, function overloading, friend and virtual functions, CPP programs based on classes, arrays and objects, CPP programs on constructors, destructors and operator overloading, CPP programs on Pointers , CPP programs on templates and file operations, CPP programs for digital circuits and AC circuits, CPP programs for steady state and transient analysis of electrical networks.

Text books:

1	Object oriented Programming with C++, E Balaguruswamy ,TMH publications 4th edition.

2	Let us C++ -Yashvanth P Kanetkar ,BPB Publications.
Reference books:	
1	Object oriented Programming with turbo C++ - Robert Lafore ,GALGOTIA Publications.
2	Programming with C++ -Schaum's series ,TMH Publications.
E Books:	
1	http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-00-introduction-to-computer-science-and-programming-fall-2008/video-lectures/lecture-14/ [Video lectures and transcripts on Object oriented programming by MIT]
2	Programming in C++ for Engineering and Science, Larry Nyhoff, CRC press, Taylor & Francis Group.

Course outcomes
At the end of the course,the student will have the ability to
CO1: Apply the basic concepts of C++ programming in developing the code for various Operations
CO2: Write C++ programs using salient features of OOPs such as Classes, Objects, Data Abstraction, Data encapsulation, Overloading, Inheritance,Polymorphism and file handling concepts for various applications.
CO3: Develop C++ programs for Electrical and Electronics Engineering applications.

Course Title	ELECTRICAL INSTALLATION, TESTING, COMMISSIONING AND MAINTENANCE (Department Elective I)				
Course Code	16EE5DE1TC	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Electrical Machines, Basic Electrical Engineering

Course Description:

The course covers topics on general principles of cost estimation of electrical installations, electrical design for residential and commercial buildings, testing of transformers and induction motor.

UNIT-I		8hours

General principles of estimation - Introduction to estimation & costing, Electrical schedule. Catalogues, Market survey and source selection. Recording of estimates, determination of required quantity of material, Labor conditions. Determination of cost material and labor contingencies. Overhead charges, profit, purchase system, purchase enquiry and selection of appropriate purchase mode. Comparative statement, purchase orders, payment of bills. Tender form, general idea about IE rule, Indian Electricity Act and major applicable I.E rules.

UNIT-II		8 hours

Residential and commercial building electrification - General rules guidelines for wiring of residential installation and positioning of equipment's**,** principles of circuit design in lighting and power circuits, procedures for designing the circuits and deciding the number of circuits, method of drawing single line diagram. Selection of type of wiring and rating of wires and cables. Load calculations and selection of size of conductor, Selection of rating of main switch. Distribution board, protective switchgear ELCB and MCB and wiring accessories, Earthing of residential Installation, Sequence to be followed for preparing estimate, Preparation of detailed estimates and costing of residential installation.

Concept of commercial installation, Differentiate between electrification of residential and commercial installation.

UNIT-III		7 hours

Electrical installation for power circuits - Introduction, important considerations regarding motor installation wiring, determination of input power, determination of input current to motors, determination of rating of cables. Determination of rating of fuse, determination of size of conduit, distribution board main switch and starter.

UNIT-IV		8hours

Testing of transformers - Specifications: Power and distribution transformers as per BIS standards.Installation: Location, site, selection, foundation details (like bolts size, their number, etc), code of practice for terminal plates, polarity & phase sequence, oil tanks, drying of windings and general inspection.

Specific Tests: Determination of performance curves like efficiency, regulation etc, and determination of mechanical stress under normal &abnormal conditions.

UNIT-V		8 hours

Induction Motors - Specifications for different types of motors, Duty, I.P. protection.

Installation: Location of the motors (including the foundation details) & its control apparatus, shaft & alignment for various coupling, fitting of pulleys & coupling, drying of windings.
Electrical Tests: Insulation test, earth resistance, high voltage test, starting up, failure to speed up to take the load, type of test, routine test, factory test and site test (in accordance with ISI code)

Text books:

1	Electrical Installation Estimating & Costing, J.B.Gupta, S.K. Katria& Sons New Delhi, VIII Edition
2	Electrical estimating and energy management, K.RgangadharaRao, Sapna. Publications.
3	Testing & Commissioning of Electrical Equipment -S. Rao,Khanna Publishers,2004

Reference books:

1	Electrical Design Estimating and Costing, K.B.Raina, S.K.Bhattacharya, New Age International
2	Electrical Wiring Estimating and Costing, S.L.Uppal, G.C Garg, Khanna Publishers, Delhi.

3	A Handbook on Operation and Maintenance of Transformers- H. N. S. Gowda, Published by H. N. S. Gowda,2006

Course Outcomes:

At the end of the course ,the student will have the ability to

CO1: Apply Indian Electricity Rules and Regulations for design of electrical systems.

CO2: Design electrical systems as per the requirements for residential and commercial purposes

CO3: Test and install electrical apparatus and HVAC systems for commercial and industrial applications

CO4: List the conditions for Install of electrical equipments

VI Semester Syllabus

Course Title	POWER SYSTEMS I				
Course Code	16EE6DCPS1	Credits	4	L-T-P-S	3-1-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Transmission and Distribution, Electrical Energy Systems

Course Description:

This course covers various techniques for analysis of different types of faults occurring in the Power System. Methods of evaluating Power System Stability are also discussed.

UNIT-I		7 hours

Representation of Power system Components: Circuit models of Transmission line, Synchronous machines, Transformer and load. Single line diagram, impedance and reactance diagram. Per unit system, per unit impedance and reactance diagrams

UNIT-II		8 hours

Formation of Z-bus using building algorithm(Without Mutuals), Symmetrical 3 - Phase Faults: Transients on a transmission line, Short-Circuit currents and the reactance of synchronous machines on load and on no load, fault analysis using Z-bus matrix

UNIT-III		8 hours

Symmetrical components - Resolution of unbalanced phasors into their symmetrical components, Analysis of unbalanced load against balanced Three-phase supply, Analysis of balanced and unbalanced loads against unbalanced 3 phase supply, Phase shift of symmetrical components in star-delta transformer bank, Power in terms of symmetrical components. Sequence impedances and networks of power system elements (alternator, transformer and transmission line) Sequence networks of power systems

UNIT-IV		8 hours

Unsymmetrical faults - L-G, L-L, L-L-G faults on an unbalanced alternator with and without fault impedance. Unsymmetrical faults on a power system with and without fault impedance. Open conductor faults in power system

UNIT-V		8 hours

Stability Analysis- Importance of stability analysis in power system planning and operation, classification of power system stability, Rotor dynamics and the swing equation. Equal area

criterion for transient stability evaluation and its applications	
Text books:	
1	Elements of Power System Analysis, WD Stevenson, McGraw Hill Publications,2nd Edition.
2	Modern Power System Analysis,IJ Nagrath and DP Kothari, Tata McGraw Hill Publications, 3rd Edition
Reference books:	
1	Computer aided Power System Analysis,GL Kusic, CRC Press, 2nd edition
2	Power System Analysis, Hadi Sadat, Tata McGraw Hill Publications, 3rd edition
E-learning:	
1	NPTEL Course titled: Computer Aided Power System Analysis. Link: http://nptel.ac.in/courses/108107028/
Course outcomes At the end of the course ,the student will have the ability to	
CO1 : Model and analyze power systems using complex mathematical transformations under short circuit and unbalanced conditions	
CO2: Analyze different unsymmetrical faults on unloaded alternator and on complex power systems using symmetrical component transformations	
CO3: Apply mathematical techniques to evaluate system stability.	

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Course Title	ELECTRICAL MACHINES II				
Course Code	16EE6DCMC2	Credits	6	L-T-P-S	3-0-1-2
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Engineering Physics, Basic Electrical Engineering

Course Description:

The course covers construction, operation, testing and control of DC machines and synchronous machines. Performance analysis of DC and synchronous machines both in motoring and generating modes are discussed.

UNIT-I		7 hours

DC machine - Construction, DC armature windings- Terminology and Types, MMF distribution, slot harmonics, Circuit model of a DC machine- generating and motoring modes, Characteristics of generator and motor, Armature Reaction, Commutation. Output equation of a DC machine, specific loadings, Separation of D and L.

UNIT-II		8 hours

Testing and Speed control of DC machines

Power flow in DC machine - Motoring and Generating modes. Testing of DC machines - Direct and indirect methods, predetermination of losses and efficiency by Swinburne's, Hopkinson's and Retardation tests, applications of DC machine. Speed control of DC shunt and DC series motors - Voltage, flux, and armature rheostat control.

UNIT-III		7 hours

Synchronous Machine :

Synchronous generators: Operating Principle, constructional features - revolving field vs revolving armature, stator, salient pole type and non-salient pole type rotor, winding factors , EMF equation, waveshape of EMF induced, armature reaction and its nature in synchronous generators,

Synchronous Motor: Principle of operation, methods of starting, nature of armature reaction in synchronous motors, power flow and efficiency of synchronous motor, Hunting and Damping,

applications of synchronous machines.

Magnetic circuit of three phase synchronous machines, Determination of field ATs of salient and non salient pole machines.

UNIT-IV		**9 hours**

Voltage regulation and methods of synchronization :

Synchronous impedance, OC and SC tests, Voltage regulation, determination of voltage regulation by EMF, MMF and ZPF methods. Slip test on salient pole alternator, voltage regulation of salient pole alternator using X_d and X_q. Need and conditions for parallel operation of alternators, Methods of synchronizing a three phase alternator to bus bars (dark lamp method, bright lamp method, synchronizing transformer, Synchronoscope). Load sharing between two alternators in parallel.

UNIT-V		**8 hours**

Operating characteristics of synchronous machine :

Synchronous machine model, operation in generating and motoring modes, circuit model. Synchronizing current and torque, Expression for power exchanged between busbars and the synchronous machine with and without armature resistance, conditions for maximum power, Power angle characteristics, Effect of change in excitation, effect of change in prime mover input and effect of change in load for both generating and motoring modes.

Lab Experiments:

Swinburne`s test, Hopkinson`s test, Retardation test, Speed control of DC motor by armature rheostatic control , flux control and Ward Leonard method, Voltage regulation of a non – salient pole alternator by EMF, MMF and ZPF method, Slip test, Synchronization of alternators in parallel with bus - bars, V curves of synchronous motor.

Text books:

1	Theory and Performance of Electrical Machines- J.B. Gupta, S.K. Kataria and Sons-New Delhi. [Unit I,II,III,IV]
2	Electrical Machines - I.J. Nagrath, D.P. Kothari, Tata Mcgraw-Hill Publishing Company Limited, New Delhi, Second Edition. [Unit V]

Reference books:	
1	Theory of Alternating Current Machinery- Alexander S. Langsdorf, Tata Mcgraw-Hill Publishing Company Limited, New Delhi, Second Edition.[Methods of synchronization]
2	Electrical Machines – Abhijit Chakrabarti , Sudipta Debnath, Mcgraw Hill Education (India) Private Limited, Newdelhi
3	A Course in Electrical machine design, A. K. Sawhney, DhanpatRai and Sons
E Books:	
1	http://nptel.ac.in/courses/108105017/
2	http://nptel.ac.in/courses/108106072/
Course Outcomes: At the end of the course ,the student will have the ability to	
CO1: Describe the constructional details, principle of operation, characteristics and speed control of DC machines and select DC motors for specific application	
CO2: Evaluate the performance of DC machine by testing them in both generating and motoring modes	
CO3: Describe the constructional details, principle of operation of synchronous machine in generating and motoring modes and their selection for specific application	
CO4: Develop synchronous machine model and evaluate the performance of synchronous machine during parallel operation	

Course Title	Power Electronics – I				
Course Code	16EE6DCPE1	Credits	6	L-T-P-S	3-0-1-2
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Analog microelectronics, Linear Circuit Analysis

Course Description :

The course deals with the principle of operation and characteristics of various switching devices,principle and analysis of operation of power conversion systems such as controlled rectifier circuits, inverters and DC choppers.

UNIT-1		8 hours

Introduction - Applications of Power Electronics, introduction to switching devices: Ideal characteristics, characteristics of practical devices, Power Semiconductor Devices, Control Characteristics of Power Devices, types of Power Electronic Circuits, peripheral Effects. Power Transistors: Power BJTs: Steady state characteristics (Qualitative analysis only). Power MOSFETs: device operation, switching characteristics, IGBTs: device operation, output and transfer characteristics, di/dt and dv/dt limitations.Gate drive circuits:MOSFET /IGBT gate drive, Isolation of gate and base drives.

UNIT-2		6 hours

DC-DC Converters - Introduction, principle of step-down operation and it's analysis with RL load (only CCM mode of operation), and principle of step-up chopper with R load, performance parameters, Chopper/Converter classification (Quadrant classification).

UNIT-3		7 hours

Thyristors - Introduction, thyristor characteristics, Two transistor model, turn on and turn off, di/dt and dv/dt protection. Steady state characteristics of TRIAC, GTO, MCT and IGCT. Thyristor firing circuits, Commutation techniques: Introduction, Natural commutation, Forced commutation: selfcommutation (Qualitative analysis only)

UNIT-4		8 hours

Controlled rectifiers - Introduction, principle of phase controlled converter operation, Single phase fully controlled converters, Single phase semi-converters, Three phase fully controlled

converters (RL load, Continuous current conduction operation only)

UNIT-5		10 hours

Inverters- Introduction, principle of operation, performance parameters, Single phase bridge inverters, Three phase inverters, voltage control of single phase inverters- single pulse width, multiple pulse width and sinusoidal pulse width modulation, Current source inverters.

Lab Experiments:

Static characteristics of SCR, MOSFET and IGBT, Simulation and practical realization of a step up and step down DC-DC converter with R and RL load, digital triggering of SCR circuit,AC voltage control using TRIAC and DIAC combination connected to R load, Simulation and practical realization of a single phase fully controlled converter and semi converter,single phase bridge inverter with R and RL load.

Text books:

1	Power Electronics – Circuits, Devices and Applications, Muhammad H Rashid, Prentice – Hall India, Third Edition.

Reference books:

1	Power Electronics – Converters, Applications and Design, Ned Mohan, Tore Undeland and William P Robbins, John Wiley &sons , 3rd Edition.
2	Power Electronics – Principles and Applications, Joseph Vithayathil, TATA McGraw-hill Edition.
3	Power Electronics, M.D.Singh, K B Khanchandani, TMH ,Second edition.

E-Resources:

1	NPTEL Lecture on "Power Electronics" http://nptel.ac.in/courses/108105066/
2	NPTEL Lecture on "Power Electronics" http://nptel.ac.in/courses/108101038/#

Course outcomes At the end of the course ,the student will have the ability to
CO1:Identify the need and methods for power conversion and control of electrical energy to match the load requirements
CO2:Analyze and compare the characteristics of an ideal switch with practically available power electronic devices.
CO3:Analyze steady state performance of different types of converters such as AC to DC, DC to AC and DC to DC converters.

Course Title	Modern Control Theory				
Course Code	16EE6DCMCT	Credits	3	L-T-P-S	2-1-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Basic Electrical Engineering, Linear Circuit analysis, Control systems

Course Description:

This course covers creation of state models using physical variables, phase variables and canonical variables and solution of state equations. It also deals with the various techniques used to analyse the controllability and observability of a system. Basics about nonlinear systems are also dealt with.

UNIT-I		8 hours

State Variable Analysis and Design - Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables & canonical variables

UNIT-II		8 hours

Derivation of transfer function from state model, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation ,state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley -Hamilton method

UNIT-III		7 hours

Concept of controllability & observability, methods of determining the same, Effect of Pole-Zero cancellation. Duality.

UNIT-IV		8 hours

Pole placement techniques - Stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer.

UNIT-V		8 hours

Non-Linear systems - Introduction, behavior of non-linear system, common physical non linearity –saturation, friction, backlash, dead zone, relay, multivariable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.

Text books:

1	Digital control &state variable methods- M.Gopal,THM Hill , 2nd edition ,2003
2	Control system Engineering- I.J .Nagarath & M. Gopal, New Age International (P)Ltd, 3rd edition

Reference books:

1	State space Analysis of Control Systems- Katsuhiko Ogata- Prentice Hall Inc
2	Automatic Control Systems- Benjamin C. Kuo & Farid Golnaraghi , John Wiley & Sons, 8th edition,2003
3	Modern Control Engineering- Katsuhiko Ogata-PHI 2003
4	Modern control systems-Dorf& Bishop- pearson education,1998

Course outcomes

At the end of the course ,the student will have the ability to

CO1: Create state models using physical variables ,mathematical variables and to solve the state equation

CO2: Apply appropriate techniques to analyze the system for its controllability and observability.

CO3: Apply relevant concepts to design systems with state feedback to meet the specifications; mathematically represent nonlinear systems and analyze a few simple models.

Course Title	UTILIZATION OF ELECTRIC POWER (Department elective II)				
Course Code	16EE6DE2UP	Credits	3	L-T-P-S	3-0-0-0
CIE	50Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Principles of DC Motors, Induction Motor and their characteristics

Course Description:

The course imparts knowledge about various types of Electric heating and welding employed in different industrial applications, interior and exterior illumination systems and design of lighting schemes. Traction systems and their behavior, Speed control and Braking of motors used in traction, Power Supply used for traction.

UNIT-I		8 hours

Electric Heating & Welding - Advantages of Electric Heating- Modes of heat transfer- Resistance heating – Infra red heating – Arc furnaces Induction Heating- High frequency eddy current heating- Dielectric heating – choice of frequency Resistance welding – arc welding- Ultrasonic welding- Laser Beam Welding, preparation of work-electrodes- Power supply for arc welding- arc welding with D.C and A.C – circuits used in Resistance welding- Comparison of different types of welding

UNIT-II		6 hours

Illumination - Production of light – Laws of illumination – lighting calculation – Determination of MHCP and MSCP – Interior and exterior illumination systems – Lighting schemes – Design on lighting schemes – Factory lighting – Flood lighting – Electrical lamps – Gaseous discharge lamps – High pressure and low pressure neon Lamps –High frequency , Low pressure discharge tubes, Induction Lamps, LED lamps, Simple problems

UNIT-III		8 hours

Electric Traction - Different types of traction- systems of Electric Traction- Track Electrification- comparison between DC and AC systems of Railway electrification Train movement and Energy Consumption: Typical Speed- Time curves- Factors affecting schedule speed simplified speed-time curve- Mechanics of Train movement-Tractive effort – Power, Energy output from the driving axles- Determination of specific energy output- factors affecting energy consumption, Specific Energy consumption- Dead weight, accelerating weight and adhesion weight- Problems

UNIT-IV		**9 hours**
Electric Traction Motors and Their Control - Introduction – Types of motors and their characteristics used for Electric Drives : D.C. Motors, A.C. Motors, Linear Induction Motor, A.C. Series Motor- Selection of Motors- Starting of D.C. Motors – Speed Control of D.C. Motors, Induction Motors – Heating & Cooling of Electrical Machines –Insulation Materials- Motors for particular Services		
UNIT-V		**8 hours**
Braking of Traction Motors and Power Supply for Traction systems- Regenerative braking- advantages and disadvantages – Calculation of energy returned- Current collector-overhead construction for tramways and trolley buses and railways-sag and tension calculation for trolley wire – substations- their location- Feeding and Distributing Systems- Interference in Telecommunication circuits.		
Text books:		
1	A Course in Electrical Power,Soni Gupta & Bhatnagar, **,**Dhanpat Rai and Sons Unit I,II,III,IV,V	
2	Utilisation of Electrical Power, Rajput, R.K., Laxmi Publications, 2008 Unit IV	
e-Books		
1	Light Emitting Diodes (Leds) For General Illumination (PDF 72P),http://www.freebookcentre.net/Electronics/Light-Emitting-Diodes PDF | 72 Pages	
2	www.edisontechcenter.org/InductionLamps.	
Reference books:		
1	Utilization of electric energy, Openshaw Taylor**,** Orient Longman89	
2	Electric Power, Uppal S. L., Khanna Publications.	

Course outcomes At the end of the course ,the student will have the ability to
CO1: Apply the knowledge of mathematics , science and electrical engineering principles to analyze operation different types of electrical heating gadgets such as ovens and welding equipment.
CO2: Apply the knowledge of mathematics and electrical engineering principles to design lighting systems for different applications.
CO3: Apply the basic knowledge of engineering to analyze the behavior of electrical traction systems under various conditions of operation.

Course Title	Circuit Design using VLSI (Department Elective II)				
Course Code	16EE6DE2CV	Credits	03	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Fundamentals of HDL

Course Description: This course helps to understand the basic concepts of various MOS technologies. The course also helps to identify the various NMOS and CMOS technologies to be used based on their applications. This course also helps to write, identify the delays in NMOS/CMOS technologies. Scaling of various parameters and use of stick diagram &mask layouts for basic circuits of VLSI can be adopted.

UNIT-I		6 hours

A Review of Microelectronic 3 and an Introduction to MOS and VLSI technologies, MOS transistors fabrication – NMOS and CMOS (N-Well & P-Well), thermal aspects, production of E-beam masks.

UNIT-II		6 hours

Relationship between Drain to Source current Ids versus Vds. MOS transistor characteristics-trans-conductance (gm) and output conductance (gds), figure of merit, NMOS Pass transistor concept. NMOS and COMS inverters. Latch up of CMOS.

UNIT-III		9 hours

Stick diagrams, design, symbolic diagrams of NMOS in NMOS design style and CMOS in CMOS design style. Importance of Lambda based rules. Basic Circuit Concepts: Sheet resistance, capacitance layer, inverter delays (NMOS, CMOS and Cascade), wiring capacitance.

UNIT-IV		8 hours

Scaling of MOS Circuits. Scaling model and scaling factors. Limitations of scaling. Subsystem Design and Layout - Some architecture issues- other systems considerations. Some observations on design process.Two input NMOS & CMOS - NAND and NOR gates

UNIT-V		10 hours

Forms of CMOS logic- Pseudo NMOS logic, Dynamic CMOS logic, CMOS domino logic, n-p CMOS logic. Examples of structural design-A Parity generator, Bus Arbitration logic for n-line

bus, 4x1 multiplexers, Four line Gray code to Binary code converter, two phase clocking. Concept of dynamic register element, Dynamic shift register. An Illustration of design process.

Text books:

1.	"Basic VLSI Design" , Pucknell Douglas Al , PHI , 3rd Edition

Reference books:

1.	Fundamentals of Modern VLSI Devices"-Yuan Taun Tak H Ning Cambridge Press, South Asia Edition 2003..
2.	"Modern VLSI Design Wayne wolf", Pearson Education Inc. 3rd edition"-Wayne Wolf 2003

Course Outcomes:

Upon the completion of the course the student must be

CO1: Able to describe and compare various types of VLSI technology. Also understand the methodology of fabrication process.

CO2: Apply the knowledge of MOS technology for simple analog/digital circuits.

CO3: Use of scaling methods based on various circuit parameters and apply scaling.

CO4: To identify the various NMOS and CMOS technology to be used based on their applications and demonstrates the working of a few VLSI circuits

Course Title	COMMUNICATION SYSTEMS (Department Elective II)				
Course Code	16EE6DE2CS	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Signals and Systems, Basic Electronics

Course Description:

This course provides an understanding of communication theory as applied to transmission of information bearing signals with equal emphasis given to both analog and digital communication techniques. This is a foundation course for Computer Communication Networks and Distribution computing courses.

UNIT-I		8 hours

Amplitude modulation: Time-Domain Description, Frequency domain description, Generation of AM waves, Detection of AM waves, Double Sideband – Suppressed Carrier Modulation, Time-Domain Description, Frequency domain description Generation of DSBSC waves, Coherent Detection of DSBSC Modulated waves. Costas Receiver, FDM

UNIT-II		8hours

Angle modulation: Basic Concepts, Frequency Modulation, Narrow Band Frequency Modulation, Wide Band Frequency Modulation, FM waves, Generation of FM waves, Direct FM, demodulation of FM waves.

UNIT-III		8 hours

Noise in Analog modulation systems: Signal-to-noise ratios, AM receiver model, Signal-to - noise ratios for coherent reception, DSBSC receiver, SSB receiver, noise in AM receivers using envelope detection, threshold effect, FM receiver model, noise in FM reception, FM threshold effect, pre-emphasis and de-emphasis in FM systems.

UNIT-IV		8 hours

Pulse modulation: Sampling theorem for low-pass and band-pass signal, PAM, natural sampling, flat-top sampling, signal recovery through holding, quantization of signals, quantization error, Pulse Code Modulation, delta Modulation, Adaptive delta modulation.

UNIT-V		7hours

Digital Modulation: Introduction, Binary Shift Keying, Phase – Shift Keying, Frequency – Shift Keying, Summary of Three Binary Signaling Schemes, line codes,TDM.

Text books:	
2.	"An introduction to Analog and Digital communication", Simon Haykin, Wiley publications, 2nd Edition.
3.	"Principles of communication systems", Taub and Schilling, Tata McGraw Hill Publications, 4th edition.
Reference books:	
3.	"Electronic Communication Systems", Blake, Thomson publishers, 2nd Edition.
4.	"Electronic Communication Systems", George Kennedy, Tata McGraw Hill Publications, 4th edition.
E-learning:	
1.	NPTEL course: Communication Engineering by Prof. Surendra Prasad, Department of Electrical Engineering, Indian Institute of Technology, Delhi
2.	NPTEL course: Advance Digital Communication by Dr. P.R. Sahu, IIT Guwahati

Course outcomes At the end of the course ,the student will have the ability to
CO1: Acquire basic knowledge of communication systems.
CO2 : Characterize and analyze different modulation techniques for analog & digital communication
CO3: Analyze the effect of noise on analog signals

Course Title	ELECTRICAL MACHINE DESIGN (Department Elective II)				
Course Code	16EE6DE2MD	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Basic electrical engineering, Electrical Machines and Geometry

Course Description:

This course provides a basic knowledge of preliminary design of rotating DC and AC electrical machines by applying fundamental knowledge of physical and mathematical principles which have been already established and considering economic aspects

UNIT-I		5 hours

Principles of Electrical Machine design and Electrical Engineering materials

Introduction, Factors and Limitations in design of electrical machines. Introduction to Computer aided design – Analysis method, synthesis method and Hybrid method. General procedure for design optimization [Examples only for discussion]

Electrical Engineering materials – conductor, magnetic and insulating materials used in electrical machines.

UNIT-II		7 hours

General Concepts and Constraints of Design of rotating electrical machines–

Relation between ratings and dimensions of rotating machines, Symbols, Main dimensions, Total loadings, Specific loadings, Output coefficient, Factors affecting size of machines, Choice of specific loadings, Variation of output and losses with linear dimensions, Separation of D and L – DC machine, Three phase Induction motor, Three phase synchronous machine, Limiting values of D and L, Ventilating ducts

UNIT-III		10 hours

Design of Armature and Commutator DC machine - Selection of number of poles, Guiding factors, Pole proportions, Length of air gap, Pole face profile. Design of Armature – Choice of Armature winding, Number of armature conductors, coils, Number of armature slots – selection and guiding factors, Cross-section of armature conductors, Insulation of armature windings, Slot dimensions, Depth of armature core.

Design of Commutator and Brushes – Commmutator diameter, number of segments, length of commutator, dimensions of brushes, Losses of Commutator surface and permissible temperature rise.

UNIT-IV		**8 hours**

Design of Three phase Cage rotor Induction Motors

Stator Design- stator winding, turns per phase, stator conductors, shape of slot, number of slots, area of slots, length of mean turn, stator teeth, stator core. Cage rotor design: Number of rotor slots- rules for selecting slots, reduction of harmonic torques,

Design of Rotor bars and slots – Rotor bar current, area of rotor bars, shape and size of slot, slot insulation. Design of end rings – End ring current, Area of end rings.

UNIT-V		**9 hours**

Design of rotor of three phase synchronous machines

Design of salient pole rotor-height of pole, design of damper winding, height of pole shoe, pole profile. Magnetic circuit, open circuit characteristics, determination of full load field MMF, design of field winding.

Design of Non salient pole rotor – rotor design of turbo alternator (type of winding, procedure for rotor winding design)

Text books:

1	A course in electrical Machine design, A.K. SAWHNEY, Dhanpat Rai and Co.
2	Principles of Electrical machine Design R.K. Agarwal

Reference books:

1	Performance and design of AC Machines M.G. Say
2	Design of Electrical Machines V.N. Mittle, Standard Publishers, 4 th Edition.

Course outcomes At the end of the course ,the student will have the ability to
CO1: Apply the knowledge of fundamental principles, factors electrical engineering materials and use of modern tools for the design of electrical machines.
CO2: Apply the general concepts and constraints in design of rotating electrical machines in design of electrical machines.
CO3: Design the dimensions of different parts and details of windings of rotating electrical machines
CO4: Analyse the effect of dimensions of the different parts of various electrical machines on the output and losses.

Course Title	Electrical & Electronics Engineering Materials (Cluster Elective I)				
Course Code	16EE6GE1EM	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Basics of Physics & Chemistry

Course Description:

This course covers basics of kinetics, chemical bonding and structure of materials. the facts of conductors, resistors and dielectric materials, different types and properties of semiconductors,concept of magnetic materials and their properties,measurement of electrical and magnetic properties of materials.

UNIT-1		7 hours

Introduction, Equilibrium, kinetics and crystal geometry - Materials science & Engineering: Classification of engineering materials, level of structure, structure-property relationship in materials.Crystal geometry: The space lattice, space lattice and crystal structure, crystal direction and planes.

UNIT-2		9 hours

Atomic structure, chemical bonding and structure of solid - Atomic structure: Quantum states, ionization potential, electron affinity and electro-negativity. Chemical bonding: bond energy, bond type and bond length, ionic bonding, covalent bonding, metallic bonding, variation of bonding character and properties.Structure of solids: crystalline and non-crystalline states, covalent solids, metal and alloys, ionic solids, the structure of silica and the silicates.

UNIT-3		7 hours

Conductors, Resistors and Dielectric materials - Conductors and resistors: The resistivity range, the free electron theory, conduction by free electrons, conductor

and resistor materials, super conducting materials.

Dielectric materials: Polarization and dielectric constant, temperature and frequency effects, electric breakdown, ferroelectric materials, piezoelectricity, dielectric losses

UNIT-4		**8 hours**

Semiconductors - Classifying materials as semiconductor, the chemical bond in Si and Ge, the density of carriers in intrinsic semiconductor; the energy gap, the conductivity of intrinsic semiconductors, extrinsic semiconductors, carrier density in n-type semiconductors, p-type semiconductors, Hall effect and carrier density, photoconductivity, fabrication of integrated circuits

UNIT-5		**8 hours**

Magnetic Materials, Measurement of Electrical and Magnetic properties -

Classification of magnetic materials, diamagnetism, the origin of permanent magnetic dipoles in matter, soft magnetic materials, hard magnetic materials, some properties of ferromagnetic materials, antiferromagnetic materials,

Measurement of Electrical and Magnetic properties: Conductivity measurements, dielectric measurements, magnetic measurements, measurements of semiconductor parameters

Text book

1	Materials Science and Engineering, V. Raghavan,PHI Learning Private Limited, Fifth Edition. 42nd reprint2013.
2	Electrical Engineering Materials, A.J. Dekker, Prentice Hall of India Private Limited, 13thre-print1988.

Reference books:

1	An Introduction to Electrical Engineering Materials,C.S.Indulkar and S. Thiruvengadam, S. Chand & Company Ltd. 3rd Edition, reprint 1985.
2	Electronic Engineering Materials and Devices, John Allison,Tata McGraw-Hill Publishing Company Ltd. 9th reprint 1990.

Course outcomes At the end of the course ,the student will have the ability to
CO1: Understand the physics of equilibrium and kinetics and crystal geometry of engineering materials.
CO2: Understand the concept of atomic structure, chemical bonding, and structure of solid.
CO3: Apply the principle of physics and mathematics to understand about the properties of conductors, semiconductors, dielectric and magnetic materials.
CO4: Apply the concept of conductor, semiconductor, dielectric and magnetic materials to measure properties of these materials

Course Title	ELECTROMAGNETIC COMPATIBILITY (Cluster Elective I – Except EC & IT)				
Course Code	16EE6GE1EC	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Analog Electronic, Digital electronics, Power electronics.

Course Description:

The course covers topics on introduction to EMI/EMC, Cabling, balancing and filtering, grounding, and shielding, Electro static discharge.

UNIT-I		8 **hours**

Introduction - Designing of electromagnetic compatibility, EMC regulation, typical noise path, and Use of network theory, method of noise coupling, miscellaneous noise sources, and method of eliminating Interference.

UNIT-II		**8 hours**

Cabling - Capacitive coupling, effect of shield on magnetic coupling, mutual inductance calculations, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, shield transfer impedance, experimental data, example of selective Shielding, co-axial cable versus shielded twisted pair braided shields.

UNIT-III		**7 hours**

Balancing and filtering - Balancing, power supply decoupling, decoupling filters, amplifier Decoupling driving capacitive loads, high frequency filtering, system bandwidth, and modulation and Coding. Introduction to Grounding - Safety grounds, signal grounds, single point ground systems, hybrid grounds, multipoint ground systems, functional ground layout, practical low frequency grounding, hardware grounds

UNIT-IV		**8hours**

Shielding - Near field and far fields, characteristic and wave impedance's shielding effectiveness, absorption loss, reflection loss, composite absorption and reflection loss, summary of shielding equation, Shielding with magnetic material, experimental data, apertures, wave guide below cut off, conductive gaskets, conductive windows, conductive coatings, cavity resonance, brooding of shields.

UNIT-V		8 hours
Electrostatic discharge - State generation, human body model, static discharge, and ESD Protection in equipment design, software and ESD protection, ESD versus EMC.		
Text books:		
1	Noise reduction techniques in electronic systems, Henry W. Ott, John Wiley, 2nd edition, 1988	
2	Engineering Electromagnetic Compatibility: Principles, Measurements & Technologies, V. Prasad Kodali, S. Chand & Co. Ltd. Delhi, 2000	
Reference books:		
1	Electromagnetics Explained – A Hand Book For Wireless/Rf,Emc And High Speed Electronics	

Course Outcomes:
After the completion of the course, the student will be able to
CO1: Analyze the fundamentals and reason for noise in Analog electronics, Power Electronics and Digital electronics circuit**.**
CO2 : Design and development of filters for Analog electronics, Power electronics and Digital circuits for reduction of noise.
CO3 : Design the various types of grounding systems and get familiarized with handling electro static discharge systems
CO4 :Acquire knowledge about testing standards and regulations.

Course Title	**Modern Control Theory (Cluster Elective I –Except EE)**

Course Code	16EE6GE1CT	Credits	03	L-T-P-S	2-1-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:

Control Systems

Course Description:

This course intends to create state models using physical variables, phase variables and canonical variables that are used to solve state equations. It also deals with the various techniques used to analyse the controllability and observability of a system. Basics about nonlinear systems are also dealt with.

UNIT-I		8 hours

State variable analysis and design:
Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables & canonical variables

UNIT-II		8 hours

Derivation of transfer function from state model, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation ,state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley -Hamilton method

UNIT-III		7 hours

Concept of controllability & observability, methods of determining the same, Effect of Pole-Zero cancellation. Duality.

UNIT-IV		8 hours

Pole placement techniques - Stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer.

UNIT-V		8 hours

Non-Linear systems - Introduction, behavior of non-linear system, common physical non linearity –saturation, friction, backlash, dead zone, relay, multivariable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.	
Text books:	
1	Digital control & state variable methods- M.Gopal,THM Hill, 2nd edition, 2003
2	Control system Engineering- I.J .Nagarath & M.Gopal, New Age International (P)Ltd, 3rd edition.
Reference books:	
1	State space Analysis of Control Systems- Katsuhiko Ogata- Prentice Hall Inc
2	Automatic Control Systems- Benjamin C. Kuo & Farid Golnaraghi , John Wiley & Sons, 8th edition, 2003
3	Modern Control Engineering- Katsuhiko Ogata-PHI 2003
4	Modern control systems-Dorf& Bishop- pearson education,1998

Course outcomes
At the end of the course ,the student will have the ability to
CO1: Create state models using physical variables ,mathematical variables and to solve the state equation
CO2: Identify appropriate techniques to analyze the system for its controllability and observability
CO3: Apply relevant concepts to design systems with state feedback to meet the specifications, Comprehend mathematical representation of nonlinear systems and analysis of a few simple models.

Assessment Pattern

Continuous Internal Evaluation (CIE) includes test, quiz, assignment, seminar, term paper,

open ended experiments, mini-projects, two minute videos, MOOCs etc.

Alternative Assessment:
Alternative Assessment Tool (AAT)includes seminar, assignments, term paper, open ended experiments, mini-projects, two minute videos, MOOCs etc.

Semester End Examination(SEE)– A written examination for theory courses and practical/design examination with built-in oral part (Viva-Voce).

Both CIE and SEE have equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

ASSESSMENT PATTERNS WITH 20% WEIGHTAGE FOR AAT
Assessment pattern for Regular/Normal courses:

COMPONENT	THEORY		TOTAL MARKS
Type of Assessment	Test	Quiz or AAT	
Max.CIEMarks	40	10	50

Assessment pattern for Integrated Courses:

COMPONENT	THEORY		PRACTICAL			Total Marks
Type of Assessment	Test	Quiz or AAT	Records & Performance	LabTest	Viva-voce/ AAT	
Max.CIEMarks	20	05	10	10	05	50

Assessment pattern for Comprehensive Courses
(Applicable for the batches admitted from 2014-15 onwards):

Component	Theory (50%)		Practical (30%)		Self-Study (20%)	Total Marks
Type of Assessment	Test	Quiz	Lab Performance/ Record	LabTest	AAT	
Max.CIE Marks	20	05	10	05	10	50

ASSESSMENT PATTERNS WITH 40% WEIGHTAGE FOR AAT

A faculty, who wishes to design AAT with more than 20% weightage, shall create a new pattern

for assessment indicating weightages for all the three components.

Note: Studentsmustsecureaminimumof40% in CIE andshouldhave85% attendance.

In case of integrated and comprehensive courses, a student must secure a minimum of 40% marks and 85% attendance in both theory and practical components. In addition, the overall CIE marks including theory, practical and self-study components shall not be less than 40%.

Note - For a detailed Assessment pattern refer Rules and Regulation book (2015-16)