GOVERNMENT COLLEGE OF ENGINEERING, AURANGABAD

(An Autonomous Institute of Government of Maharashtra)

Department of Electrical Engineering

Teaching and Evaluation Scheme

ME ELECTRICAL (Electrical Machines & Drives) Full Time

SEMESTER-I

(Implemented from 2015 admitted students)

THEORY COURSES													
S. No.	**Course Code**	**Subject**	**Scheme of Teaching (Hrs/Week)**			**Total Credits**	**Scheme of Evaluation (Marks)**					
							Theory			**Term Work**	**Practical & Viva-voce**	**Total**
			L	**T**	**P**		**Test**	**TA**	**ESE**			
1	EE 641	Electrical Machine Modeling and Analysis	03	01		04	20	20	60			100
2	EE 642	Modern Power Electronics	03	01		04	20	20	60			100
3	EE 643	Modern Control Systems	03	01		04	20	20	60			100
4	EE 644	Control of Electrical Drives-I	03			03	20	20	60			100
5	EE 645 – EE651,EE549,EE561, EE 679	Elective-I	03			03	20	20	60			100
LABORATORY COURSES												
7	EE 653	Engineering Computational Laboratory			04	02				25	25	50
8	EE 655	Control Systems Laboratory			04	02				25		25
9	EE 656	Seminar-I			02	02				25		25
A]	**Total of Semester I**		**15**	**03**	**10**	**24**	**100**	**100**	**300**	**75**	**25**	**600**

SEMESTER-II

THEORY COURSES												
S. No.	**Course Code**	**Subject**	**Scheme of Teaching (Hrs/Week)**			**Total Credits**	**Scheme of Evaluation (Marks)**					
							Theory			**Term Work**	**Practical & Viva-voce**	**Total**
			L	**T**	**P**		**Test**	**TA**	**ESE**			
1	EE 657	Microcontroller and its Application	03			03	25	25				50
2	EE 658	Control of Electrical Drives-II	03			03	20	20	60			100
3	EE 659	Special Machines	03			03	20	20	60			100
4	EE 660	Digital Signal Processing	03			03	20	20	60			100
5	EE 661– EE 666, EE 548, EE 566, EE 563	Elective –II	03			03	20	20	60			100
6	EE 667	Electrical Machine Design	02			02	25	25				50
LABORATORY COURSES												
8	EE 669	DSP Laboratory			04	02				25		25
9	EE 670	Microcontrollers Laboratory			02	01				25		25
10	EE 678	Electrical Drives Laboratory			04	02				25		25
11	EE 672	Seminar-II			02	02				25		25
		In-plant Training*										
B]	**Total of Semester II**		**17**	**00**	**12**	**24**	**130**	**130**	**240**	**100**	**00**	**600**
Total of Semester (A+B)			**32**	**03**	**22**	**48**	**230**	**230**	**540**	**175**	**25**	**1200**

*** Students will complete their in-plant training in industries for maximum one month and minimum one week during summer vacation (after 2nd semester) and accordingly submit the report and present the seminar in third semester.**

SEMESTER III

THEORY COURSES													
S. No.	**Course Code**	**Subject**	**Scheme of Teaching (Hrs/Week)**			**Total Credits**	**Scheme of Evaluation (Marks)**					
							Theory			**Term Work**	**Practical & Viva-voce**	**Total**
			L	**T**	**P**		**Test**	**TA**	**ESE**			
1	EE 673	Dissertation Phase-I Seminar			20	10				50		50
2	EE 674	Renewable Energy Technology (Institute level open elective)	03	01		04	20	20	60			100
4	EE 675	Environmental Engineering	03			03	20	20	60			100
C]	**Total of Semester III**		**06**	**01**	**20**	**17**	**40**	**40**	**120**	**50**	**00**	**250**
			SEMESTER IV									
1	EE 676	Dissertation Phase-II			20	10				25	75	100
2	EE 677	Comprehensive viva-voce				01					50	50
D]	**Total of Semester IV**		**00**	**00**	**20**	**11**	**00**	**00**	**00**	**25**	**125**	**150**
Total of All Semester(A+B+C+D)			**38**	**04**	**62**	**76**	**270**	**270**	**660**	**250**	**150**	**1600**

L-Lectures, T-Tutorials, P-Practical's, TA-Teacher Assessment, ESE-End-Semester Examination

List of Electives Semester - I			**List of Electives Semester –II**		
1	EE 645	Industrial Automation & Control	1	EE 661	Finite Element Methods
2	EE 646	Industrial Controller	2	EE 662	Engineering Materials
3	EE 647	Hysteresis Machines	3	EE 663	Reliability and conditioning Monitoring
4	EE 648	Embedded Systems	4	EE 664	DSP processors
5	EE 649	VLSI	5	EE 665	Optimal Control Systems
6	EE 650	Electrical Drives Application	6	EE 666	Electric Traction
7	EE 651	Biomedical Instrumentation	7	EE 548	Power systems Reliability
8	EE 549	Solar Energy Systems	8	EE 563	Illumination Engineering
9	EE 561	Smart Grid :Technologies and Applications	9	EE 566	Wind Energy Systems
10	EE 679	Power Quality			

ME (Electrical Machines and Drives)

Semester-I

EE 641: ELECTRICAL MACHINES MODELING AND ANALYSIS

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Tutorial	01Hrs/week		
Total Credits	04	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Basic concepts of Modeling**:**
Basic Principles of Electrical Machine Analysis, Need of modeling, Introduction to modeling of electrical machines, Kron's primitive Machine

UNIT-2 Concept of transformation:
Commonly Used Reference Frames, change of variables & m/c variables and transform variables for arbitrary reference frame. Stationary Circuit Variables Transformed to the Arbitrary Reference Frame, Transformation Between Reference Frames, and Transformation of a Balanced Set, Balanced Steady State Phasor Relationships, And Balanced Steady State Voltage Equations.

UNIT-3 Modelling of Direct-Current Machine:
Voltage and Torque Equations in Machine Variables, Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis, Application to D.C. machine for steady state and transient analysis,

UNIT-4 Polyphase Induction Machines:
Modelling of 3 phase Induction Motor, Voltage, torque equations, Equivalent circuit, Steady state analysis, Dynamic performance during sudden changes in load torque and three phase fault at the machine terminals.

UNIT-5 Polyphase Synchronous Machine:
Modeling of synchronous machines, Voltage and Torque Equations in stator, rotor and air-gap field reference frames using Parks Transformations, Voltage and power equation for salient and non-salient alternator, Simplified equations of a synchronous machine with two damper coils, Dynamic Performance During Sudden Changes in Load Torque, Dynamic Performance During a Three-Phase Fault at the Machine Terminals, Approximate Transient Torque Versus Rotor Angle Characteristics , Comparison of Actual and Approximate Transient Torque-Angle Characteristics during a Sudden Change in Input Torque.

UNIT-6 Modeling Permanent Magnet Synchronous Machine: Introduction, Types of Permanent Magnet Synchronous Machines, PMAC & PMDC(BLDC) ,Voltage and torque equations in machine variables, voltage and torque equations in rotor reference frame variables, Block diagram and transfer functions, and applications.

BOOKS

1. P.C. Krause, “Analysis of Electric Machinery, McGraw Hill”, NY, 1987
2. C.V. Jones, “The unified Theory of Electrical Machines”, Butterworth,-London, 1967
3. Stevenson, “Power System Analysis”, McGraw Hill, NY
4. Dhar R.N., “Computer Aided Power System Operation and Analysis”, Tata McGraw Hill
5. P.S. Bhimbra, “The Generalised Theory of Electrical Machines”, Tata McGraw Hill
6. B.Adkins&R.G.Harley, “The General theory of AC Machines”, Tata McGraw Hill
7. R. Krishnan, “Electric Motor Drives – Modelling, Analysis and Control”, PHI
8. Learning Private Limited, New Delhi, 2011.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mr. P. S. Swami

EE 642: Modern Power Electronics

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Tutorial	01Hrs/week		
Total Credits	04	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Power Semiconductor Devices:
Structure, working principle, V-I characteristics, switching characteristics and protection circuits of Thyristors, Triac, GTOs, BJT, Power MOSFETS, SIT, IGBT, MCT, IGCT, PIC

UNIT-2 Thyristor converters:
Single phase and three phase converter, dual converter, converter control, EMI and line power quality problems, phase-controlled cycloconverters, control of cycloconverters, matrix converters, high frequency cycloconverter

UNIT-3 DC-DC converter:
Switching mode regulators, diode rectifier fed boost converter, chopper circuit diagram, static switches, AC machines, DC switches, solid state relays, design of static switches

UNIT-4 Inverters:
PWM inverters, resonant pulse inverters, series and parallel resonant inverters, Voltage control of resonant inverters, Class E resonant inverter and rectifier, zero current and zero voltage switching resonant converters, resonant DC link inverters, multilevel inverters, diode clamped multilevel inverters, flying capacitor multilevel inverters, cascaded multilevel inverters, applications and features of multilevel inverters, DC link capacitors voltage balancing

UNIT-5 Power supplies:
DC power supplies, AC power supplies,Multistage converters, control circuits, magnetic design considerations

Books:

1. M. H. Rashid, “Power Electronics”, PHI publication
2. B.K. Bose, “Power Electronics and AC Drives”, Prentice Hall, 1986
3. Andrzej M. Trzynadlowski, “Introduction to Modern Power Electronics”, Wyley

Teacher Assessment:

Assessments will be based on following -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By : Mr.S. S. Dhamse

EE 643: Modern Control Systems

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Tutorial	01Hrs/week		
Total Credits	04	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 State feedback control system:
Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, physical systems and state assignment concept of controllability & observability, State feedback by pole placement, observers, Lag and Lead compensator design.

UNIT-2 Robust control system:
Robust control systems and system sensitivity, Analysis of robustness, system with uncertain parameters, design of robust control system.

UNIT-3 Non-linear Control system:
Introduction to non-linear systems, Describing function analysis, phase plane analysis, bang bang control system, Lyapunovs stability analysis,

UNIT-4 Optimal Control System:
Introductionto optimal control system, problems, Quadratic performance index, Introduction to Adaptive control

UNIT-5 Process control system:
Introduction to process control, various control configuration such as: feedforward, cascaded etc. PID controller and implementation.

BOOKS

1. S. Sastry and M. Bodson, “Adaptive Control: Stability, Convergence, and Robustness”, Prentice-Hall, 1989.
2. Gopal. M., “Control Systems: Principles and Design”, Tata McGraw-Hill, 1997.
3. Kuo, B.C., “Automatic Control System”, Prentice Hall, sixth edition, 1993.
4. Ogata, K., “Modern Control Engineering”, Prentice Hall, second edition, 1991.
5. Nagrath& Gopal, “Modern Control Engineering”, New Age International

Teacher Assessments:

Assessments will be based on following:

1. Assignment 10Marks
2. MCQ 10 Marks

Designed By : Dr. A. G. Thosar

EE 644: Control of Electrical Drives-I

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Basics of Electrical Drives:

Concepts of electric drives, classification of electric drives, classification of control schemes, classification of methods of speed control, components of electric drives, types of Load. Classification, comparison of AC and DC drives, components of power electronic drives, criteria for selection of drive components, match between the motor and the load, match between the motor and power electronics converter.

UNIT-2 Modeling of DC Machines:

Theory of Operation, Induced EMF, Equivalent Circuit and Electromagnetic Torque, Electromechanical Modeling, State space modeling, Block Diagram & Transfer Function, Field Excitation, Separately excited DC machine, Shunt-excited DC machine, Series-excited DC machine, DC Compound Machine, Permanent-Magnet Dc Machine, Measurement of motor Constant, Armature Resistance, Armature inductance, emf constant, Flow chart for Computation.

UNIT-3 Phase Controlled DC Motor Drives**:**

Introduction, Principles of DC motor speed Control, Phase Controlled Converters, Steady state Analysis of the three phase Converters-Controlled DC Motor Drive, Two quadrant, three phase converter-controlled DC motor Drives, Transfer functions of the subsystems, Design of controllers, two quadrant DC motor drives with field weakening, four quadrant DC motor drives, Converter selection and characteristics, Simulation of the one- quadrant DC motor drives, Harmonics and associated problems, sixth harmonic torque, applications.

UNIT 4 Chopper Controlled DC Motor Drive:

Introduction, Principle of operation the chopper, Four quadrant chopper circuit, Chopper for inversion, chopper with other power devices , model of the chopper, input to the chopper, other chopper circuits, steady state analysis of chopper – controlled DC motor drives, Rating of the devices, Pulsating torques, Closed loop operation, dynamic simulation of the speed controlled DC motor drives, application.

UNIT 5 Polyphase Induction machines:

Introduction, Construction and principle of operation, induction motor equivalent circuit, Steady state performance equations of induction motor, Steady state performance, Measurement of motor parameters, dynamic modeling of induction machines, Dynamic Simulation, Small Signal Equations of the Induction Machine, Evaluation of control characteristics of the induction machine, Space Phasor model, Controlprinciple of induction motor.

Phase Controlled Induction motor Drives:

Introduction, stator voltage control, Slip energy recovery scheme, Steady state analysis, starting, Ratings of converters, closed loop control, Sixth harmonic, pulsating torques, Harmonic Torques, static scherbius Drive, applications

BOOKS

1. R. Krishan, "Electric Motor Drives- Modelling Analysis and Control", Pearson Prentice Hall.
2. G.K. Dubey, "Fundamentals of Electrical Drives", Narosa Publication
3. N.K. De and P.K.Sen "Electric Drives", Prentice Hall India
4. B.K. Bose, "Power Electronics and Variable Frequency Drive", IEEE Press, 2000
5. VedamSubramanyam, "Electric Drives Concepts and Applications", Tata McGraw-Hill

Teacher Assessments:

Assessments will be based on following:

1. Assignment 10Marks
2. MCQ 10 Marks

Designed By: Dr. A. G. Thosar

& S. S. Dhamse

EE 653: ENGINEERING COMPUTATIONAL LABORATORY

(Compulsory)
(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Practical	04Hrs/Week	Term work	25 Marks
Total Credits	02	Viva-voce	25 Marks

Term Work

Term work shall consist of record of minimum eight experiments/assignments using engineering computation software such as MATLAB, PSCAD, ETAP with moderate to high complexity.

EE 655: CONTROL SYSTEM LABORATORY

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Practical	04Hrs/Week	Term work	25 Marks
Total Credits	02		

Term Work

The term work shall consist of record of minimum eight experiments from the list given below.

1. To design and study the effect of different Compensation for given system using MATLAB
2. To design and study the effect of different Compensation for given system using experimental kit
3. To simulate the DC motor speed control using armature voltage control with MATLAB Simulation
4. To simulate the DC motor speed control using armature voltage control with experimental kit
5. To simulate the DC motor speed control using field current control with MATLAB Simulation
6. To simulate the DC motor speed control using field current control with experimental kit
7. MATLAB program for state space analysis to transfer function, transfer function to state space analysis, controllability, observability, digonalisation of the system
8. Study of magnetic laviation using kit
9. To study transfer function of any one physical system
10. Any other relevant experiment faculty may add

Designed By : Dr. A. G. Thosar

EE 656:SEMINAR-I

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Practical	02Hrs/Week	Term work	25 Marks
Total Credits	02		

Student will present seminar on work done by them on any topic relevant to syllabus. The seminar should include some simulations carried out by students.

ME (Electrical Machines and Drives)

Semester-II

EE657: MICROCONTROLLERS & ITS APPLICATIONS

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	25 Marks
Total Credits	03	Teacher Assessment	25 Marks

UNIT-1 Advanced Microprocessors:
Architecture Of Typical 16 Bit Microprocessor(Intel 8086), Memory Address Space And Data Organization, Segment Registers And Memory Organization, Addressing Modes,8086 Configurations, Minimum Mode, Maximum Mode, Comparison of 8086 And 8088, Bus Interface, Interrupts and Interrupt Priority Management.

UNIT-2 Programming 8086:
Instruction Set, Assembly Language Programming, Input/ Output Operations, Interfacing Of Peripheral Devices Like 8255, 8259, LED etc.

UNIT-3 Multiprocessor System:
Queue Status And Lock Facility Of 8086 Based Multiprocessor System, 8087 Coprocessor, Concept, Architecture, Instruction Set And Programming.

UNIT-4 Microcontrollers:
Introduction, Evolution, Architecture, Comparison With Microprocessor, Selection Of A Microcontroller, MCS 51 Family, 8051 Architecture, I/O Ports And Memory Organization Addressing Modes, Instruction Set, Interrupts, Real World Interfacing.
Overview of Atmel Microcontrollers 89CXX.

UNIT-5 Application of Microcontrollers and its interfacing**:**
Solenoids- Relay control and clamping pick/hold heaters, LED, LCD, DAC, Actuators.
Motors-i) Stepper Motors- bipolar and unipolar operation, half stepping and micro-stepping, stepper motor driver circuit
ii) DC Motors- driving dc motors, BLDC motor and its driving, DC motor controller
Case Studies: Case study of 8051 based systems like Numerical Protection relays, Intelligent Transformer, Intelligent Switchgear, High efficiency Induction Motors, Electronic speed governors, Auto synchronizing unit.

BOOKS

1. MykePredko, “Programming and customizing the 8051 Microcontroller”, Tata McGraw Hill, New Delhi.
2. Badri Ram, “Advanced Microprocessor and interfacing”, Tata McGraw Hill, New Delhi.

3. Barry B Brey, “The Intel Microprocessor 8086 to Pentium architecture programming and interfacing”, Tata McGraw Hill, New Delhi.
4. M.A. Mazidi&G.M. Mazidi,” The 8051 Microcontroller and Embedded System “,Pearson education, 3rd Indian reprint.
5. Ajay Deshmukh, “Microcontrollers”, Tata McGraw Hill, New Delhi.
6. Embedded Microcontroller Intel Manual
7. Intel Data Handbook for MCS96 Family
8. Kenneth Ayala, 8051 Microcontroller, Pen ram international, IInd edition
9. Online reference www.microchip.com

Teacher Assessments:

Assessments should be based on –

1) Write the ALP programme for real time application using microcontroller/processor 10 Marks
2) Design prototype model and simulation 10 Marks
3) PPT presentation 05 Marks

Designed By :Mrs. S. S. Kulkarni

EE 658: CONTROL OF ELECTRICAL DRIVES II

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Voltage Fed Converters:
Introduction, single phase inverters, three phase bridge inverters, multi stepped inverters, PWM techniques, three level inverters, hard switching effects, resonant inverters, soft- switched inverters, dynamic and regenerative drive braking, PWM rectifiers, Static VAR compensators

UNIT-2 Current Fed Converters**:**
Introduction, general operation of six step thyristor inverter, load commutated inverter, force commutated inverters, harmonic heating and torque pulsation, multi stepped inverters, inverter with self-commutated devices

UNIT-3 Induction Motor Slip-Power Recovery Drives:
Introduction, doubly fed machine speed control by rotor rheostat, static Kramer drive, static Scherius drive, modified static Scherius drive

UNIT-4 Control and Estimation of Induction Motor Drives:
Introduction, Induction motor control with small signal model, scalar control, vector or field oriented control, sensorless vector control, direct torque andflux control, adaptive control, self-commissioning of drive

UNIT-5 Control of Estimation of Synchronous Motor Drives:
Introduction, sinusoidal SPM machine drives, synchronous reluctance machine drives, sinusoidal IPM machine drives, trapezoidal SPM machine drives, wound field synchronous machine drives, sensor less control, switched reluctance motor drives

BOOKS

1. B. K. Bose, “Modern Power Electronics and AC drives”, Pearson Education, Asia, 2003
2. M. H. Rashid, “Power Electronics”, Third Edition, PHI
3. G. K. Dubey,” Fundamentals of Electrical Drives”, Narosa Publishing house
4. V. Subrahmanyam, “Electric Drives-Concepts and Applications”, TMH
5. G. K. Dubey, “Power Semiconductor controlled drives”, PH 1989.
6. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, PH, 1998
7. P. Vas, “Sensor less vector and direct torque control”, Oxford Press, 1998 8. W. Leonard, “Control of Electric Drives”, Springer Verlag, 1985.

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Dr. A. G. Thosar&
Mr.S. S. Dhamse

EE 659: SPECIAL MACHINES

(Compulsory)

(Implemented from 2015)

Teaching Scheme

Lectures 03Hrs/Week

Total Credits 03

Evaluation Scheme

Class Test : 20 Marks

Assignment : 20 Marks

End- Sem Exam: 60 Marks

UNIT-1 Servo motors:

Symmetrical components applied to two - phase servo motors - equivalent circuit and performance based on symmetrical components - servo motor torque - speed curves.

UNIT-2 Stepper motors:

Construction features - method of operation - drive - amplifiers and transistor logic - half stepping and the required switching sequence - the reluctance type stepper motor - ratings and other characteristics.

UNIT-3 Reluctance motors:

General types of synchronous motors - reluctance - motors - definitions - construction - polyphase and split phase reluctance motors - capacitor type reluctance motors - hysteresis motors - construction - polyphase - capacitor type and shaded pole hysteresis motors - universal motors - universal motors - application and torque - characteristics - essential parts of universal motors

Switched Reluctance Motor: Construction, operating performance, control and applications

UNIT-4 Linear machines:

basic difference between LEMS and rotating - machine - classification of LEMS, linear motors and levitation machines - linear induction motors - linear synchronous motors - DC linear motors - linear levitation machines

UNIT-5 Induction generators:

Self-excitation requirements, steady state analysis, voltage regulation, different methods of voltage control, application to mini and micro hydel systems.

Doubly fed induction machines: control via static converter, power flow, voltage/frequency control (generation mode), application to grid connected wind and mini/micro hydel systems.

UNIT-6 Brushless DC Machines:

Construction operation, performance, control and applications.

Application of permanent magnets in electrical machine: structure, magnetic materials used, Types of motors e.g. PMDC and PM Synchronous Machine, control and applications

Recent developments in electrical machines

TEXT AND REFERENCE BOOKS

1. Toro V.D, “Electric machines and power systems”, Prentice Hall of India, 1985
2. Veinott, “Fractional horse power electric motors”, Mc Graw Hill, 1948
3. Nasar.S.A, Boldeal, “Linear Motion Electric machine”, John Wiley,1976
4. A. E. Fitzergerald, C.Kingsly, S.D.Umas, “Electric Machinery”, TMH

Teacher Assessment:

The teacher’s assessment should be based on mentioned contents and following methods,

Out of four first is compulsory and from the remaining any one should be taken.

1. Assignments* 10 Marks
2. Objective type test 10 Marks
3. Modeling of electrical machines using any electrical software 10 Marks
4. Technical/Industrial visit report 10 Marks

*** Assignment** should be based on -

Design of Synchronous machine, D.C. machine, Transformer, Induction motors, orany special machine theoretically / by using any software such as MATLAB/Simulink, ANSYS, EMTDC etc.

Designed By: Mrs. M. R. Bachawad

EE 660: DIGITAL SIGNAL PROCESSING

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Signals and Signal Processing:

Characterization and Classification of Signals, Typical Signal Processing Operations, Examples of Typical Signals, Typical Signal Processing Applications, Why Digital Signal Processing?

Discrete-Time Signals and Systems in the Time-Domain: Discrete-Time Signals, Typical Sequences and Sequence Representation, the Sampling Process, Discrete-Time Systems, Time-Domain Characterization of LTI Discrete-Time Systems, Finite-Dimensional LTI Discrete-Time Systems, Correlation of Signals, Random Signals

UNIT-2 Transform-Domain Representations of Discrete-Time Signals:

The Discrete-Time Fourier Transform, Discrete Fourier Transform, Relation Between the DTFT and the DFT, and Their Inverses, Discrete Fourier Transform Properties, Computation of the DFT of Real, Sequences, Linear Convolution Using the DFT, The z-Transform, Region of Convergence of a Rational z-Transform, The Inverse z-Transform, z-Transform Properties, Transform-Domain Representations of Random Signals

LTI Discrete-Time Systems in the Transform-Domain

Finite-Dimensional LTI Discrete-Time Systems, The Frequency Response, The Transfer Function, Types of Transfer Functions, Simple Digital Filters, All-pass Transfer Function, Minimum-Phase and Maximum-Phase Transfer Functions, Complementary Transfer Functions, Inverse Systems, System Identification, Digital Two-Pairs, Algebraic Stability Test, Discrete-Time Processing of Random Signals, Matched Filter

UNIT-3 Digital Processing of Continuous-Time Signals**:**

Introduction, Sampling of Continuous-Time Signals, Sampling of Band pass Signals, Analog Low pass Filter Design, Design of Analog High pass, Band pass, and Band stop Filters, Anti-Aliasing Filter, Design of Sample-and-Hold Circuit, Analog-to-Digital Converter, Digital-to-Analog Converter, Reconstruction Filter Design, Effect of Sample-and-Hold Operation.

UNIT-4 Digital Filter Structures**:**

Block Diagram Representation, Equivalent Structures, Basic FIR Digital Filter Structures, Basic IIR Filter Structures, Realization of Basic Structures using MATLAB, All pass Filters, Tunable IIR Digital Filters, IIR Tapped Cascaded Lattice Structures, FIR Cascaded Lattice Structures, Parallel All pass Realization of IIR Transfer Functions, Digital Sine-Cosine Generator.

UNIT-5 Digital Filter Design**:**

Preliminary Considerations, Bilinear Transform Method of IIR Filter Design, Design

of Low pass IIR Digital Filters, Design of Highpass, Bandpass, and Bandstop IIR Digital Filters, Spectral Transformations of IIR Filters, FIR Filter Design Based on Windowed Fourier Series, Computer-Aided Design of Digital Filters, Design of FIR Filters with Least-Mean-Square Error, Digital Filter Design Using MATLAB
Applications of Digital Signal Processing
Position and Speed Control of Stepper Motor, DC Motor Speed Control, Serial Communications and Data Transfer, Sine Modulated PWM Signal Generation

BOOKS

1. Proakis," Digital Signal Processing", Pearson Education Limited
2. Oppenheim and Schafer, "Discrete-Time Signal Processing",, Prentice-Hall, 1989.
3. Ambardar Ashok, "Digital Signal Processing: A Modern Introduction", Penram International Publishing (India) Pvt. Ltd.
4. Rabiner, Lawrence R., "Theory and Application of Digital Signal Processing", Gold, Bernard, PrenticeHall
5. H.A. Toliyat& S.G. Campbell, "DSP-Based Electromechanical Motion Control", CRC Press 2003

Teacher Assessments:

Assessments should be based on -

1. Assignment 10 Marks
2. MCQ 10 Marks

Designed By: Mr.V. P. Dhote

EE 667: ELECTRICAL MACHINE DESIGN

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	02Hrs/Week	Test	25 Marks
Total Credits	02	Teacher Assessment	25 Marks

UNIT-1 Fundamentals aspects of electrical machine design:
Major considerations and limitations in design, Design factors, Electrical Engineering Materials, Thermal considerations, Rating of machines, Standard specifications, modern machine design techniques

UNIT-2 Magnetic circuit Design:
Calculations of ampere turns for flux distribution in rotating machines, carter's coefficient and its significance, air gap flux distribution in electrical machines.

UNIT-3 General Concepts and constraints in design of rotating machines:
output equations and main dimensions for rotating machines, factors affecting size of rotating machines , specific electrical and Magnetic loadings , separation of D and L for rotating machines

UNIT-4 Transformers Design:
Output Equations – Main Dimensions - KVA output for single and three phase transformers – optimum design of transformer ,Design of yoke, core and winding, Overall dimensions, Operating characteristics Regulation – No load calculation Temperature rise in Transformers – Design of Tank and cooling tubes

UNIT-5 Induction motor Design:
Output equation of Induction motor – Main dimensions – 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 ,Magnetizing current - Short circuit current – Circle diagram - Operating characteristics.

TEXT AND REFERENCE BOOKS

1. A.K. Sawhney, "A Course in Electrical Machine Design'', Dhanpat Rai & Sons, New Delhi, sixth Edition 2006.
2. S.K.Sen, , 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987.
3. M.G.Say "Theory, Performance and Design of A.C. Machines'', ELBS, LONDON,Third Edition 2006.
4. A. Shanmugasundaram, G. Gangadharan, R. Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint 2007.

Teacher Assessment:

The teacher's assessment should be based on mentioned contents and following methods,

Out of four first is compulsory and from the remaining any one should be taken.

1. Assignments* 15 Marks
2. Objective type test 10 Marks
3. Modeling of electrical machines using any electrical software 10 Marks
4. Technical/Industrial visit report 10 Marks

*** Assignment** should be based on -

Design of Synchronous machine, D.C. machine, Transformer, Induction motors, or any special machine theoretically / by using any software such as MATLAB/Simulink, ANSYS, EMTDC etc.

Designed By: Mrs. M. R. Bachawad

EE 669: DSP LABORATORY

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	04Hrs/Week	Term work	25 Marks
Total Credits	02		

Term Work

The term work shall consist of record of minimum six experiments from the list given below.

1. Architecture of DSP chips-TMS 320C 6713 DSP Processor
2. Linear convolution
3. Circular convolution
4. FIR Filter (LP/HP) Using Windowing technique
5. Rectangular window
6. Triangular windoKaiser window
7. IIR Filter(LP/HP) on DSP processors
8. N-point FFT algorithm
9. Power Spectral Density of a sinusoidal signals
10. FFT of 1-D signal plot
11. MATLAB program to generate sum of sinusoidal signals
12. MATLAB program to find frequency response of analog filters (LP/HP)
13. Simulation of Position and Speed Control of Stepper Motor,
14. Simulation of DC Motor Speed Control

Designed By : Mr.V.P.Dhote

EE 670: MICROCONTROLLER LABORATORY

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Practical	02Hrs/Week	Term work	25 Marks
Total Credits	01		

EE 678: DRIVES LABORATORY- II

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Practical	04Hrs/Week	Term work	25 Marks
Total Credits	02		

Student shall perform minimum six experiments out of following and submit the term work which shall consist of record of the experiments performed.

1. Three experiments based on study and / or simulation of electric drives (mentioned in the syllabus) using MATLAB/SIMULINK/PSPICE
2. Study of DC motor control
3. Study of V/F induction motor control
4. Study of vector control of induction motor
5. Study of synchronous motor drive
6. Study of brushless motor drive

EE 672:SEMINAR-II

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	02Hrs/Week	Term work	25 Marks
Total Credits	02		

Student will present seminar on work done by them on any topic relevant to syllabus. The seminar should include some simulations carried out by students

ME (Electrical Machines and Drives)

Semester-III & IV

EE 673:DISSERTATION PHASE I SEMINAR

(Compulsory)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	18Hrs/Week	Term work	50 Marks
Total Credits	09		

Students will present a seminar on the dissertation work carried out as a part of term work. The department will constitute a committee of three members to evaluate the presentation. The committee will have following structure.

1. Head of the department - chairman
2. Guide - member
3. Subject expert from institute/industry – member

The committee will monitor the quality of the dissertation work.

EE 677:Comprehensive Viva-Voce

(Compulsory)
(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
		Practical/viva-voce	50 Marks
Total credit	01		

EE 674: RENEWABLE ENERGY TECHNOLOGY

(Compulsory)

(Implemented from 2015)

TeachingScheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Tutorial	01Hrs/Week	Teacher Assessment	20 Marks
		End Semester Exam	60 Marks
Total Credits	04		

UNIT-1 Distributed Generation**:**
Distributed Generation with Fossil Fuels, Concentrating Solar Power (CSP) Technologies, Biomass for Electricity, Micro-Hydropower Systems, Fuel Cells, Electrical Characteristics of Real Fuel Cells, Types of Fuel Cells, Hydrogen Production

UNIT-2 Wind Power Systems**:**
Historical Development of Wind Power, Types of Wind Turbines, Power in the Wind, Impact of Tower Height, Maximum Rotor Efficiency, Wind Turbine Generators, Speed Control for Maximum Power, Average Power in the Wind, Simple Estimates of Wind Turbine Energy, Specific Wind Turbine Performance Calculations, Wind Turbine Economics

UNIT-3 The Solar Resource**:**
The Solar Spectrum, The Earth's Orbit, Altitude Angle of the Sun at Solar Noon, Solar Position at any time of Day, Sun Path Diagrams for Shading Analysis, Solar Time and Civil (Clock) Time, on a Collecting Surface, Monthly Clear-Sky Isolation, Solar Radiation Measurements, Average Monthly Isolation

UNIT-4 Photovoltaic Materials and Electrical Characteristics**:**
The PV I–V Curve Under Standard Test Conditions (STC), Impacts of Temperature and Isolation on I –V Curves, Shading Impacts on I–V Curves, Crystalline Silicon Technologies, Thin-Film Photovoltaic Systems, Current–Voltage Curves for Loads, Grid-Connected Systems, Grid-Connected PV System Economics, Stand-Alone PV Systems, PV-Powered Water Pumping

TEXT AND REFERENCE BOOKS

1. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", Wiley-IEEE Press August 2004
2. Siegfried Heier, "Rachel Waddington Grid Integration of Wind Energy Conversion Systems", WileyPublications.
3. "Power Generation Renewables" by PEP (Professional Engineering Publishers) Wiley

publications
4. Thomas Ackermann, “Wind Power in Power Systems”, Wiley publication

Teacher Assessment:

Assessment will be based on following:

1. Assignments 10 Marks
2. MCQ 10 Marks

Designed By: Mr. S. M. Shinde

EE 676:DISSERTATION PHASE II

(Compulsory)

(Implemented from 2014)

Teaching Scheme		**Evaluation Scheme**	
Practical	20Hrs/Week	Term work	25Marks
Total Credits	10	Practical / Viva-voce	75 Marks

Student will present a seminar on the dissertation work carried out as a part of term work. The department will constitute a committee of three members to evaluate the presentation. The committee will have following structure.

1. Head of the department- chairman
2. Guide - member
3. Subject Expert from Institute/Industry – member

The committee will monitor the quality of the dissertation work.

EE 675:Environment engineering

(Compulsory)

(Implemented from 2015)

TeachingScheme		**Evaluation Scheme**	
Lectures	04Hrs/Week	Test	20 Marks
Total credits	04Hrs/Week	Teacher Assessment	20 Marks
		End Semester Exam	60 Marks

ME (Electrical Machines and Drives)
Electives

EE645: POWER QUALITY

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End semester Exam	60 Marks

Prerequisites:

EE356 - Power Electronics

Course Educational Objectives:

The objectives of the course are to

1. Understand electrical power quality problems
2. Develop ability for effective measurement of power quality problems
3. Understand harmonic problem in system
4. Overcome harmonics in system by designing harmonic filters
5. Make aware about power quality measuring instruments /devices
6. Identify the test location and duration of test for power quality problem, custom power devices, power quality standards, losses in system because of power quality disturbance

Course Outcomes:

Students will be able to

1. Understand definitions of power quality, power quality standards.
2. Classify power quality problems.
3. Identify power quality disturbances.
4. Distinguish between voltage sag and swell.
5. Understand the methods to mitigate harmonics in system
6. Design Passive filters.
7. Instruments/ devices to measure power quality
8. Know test locations and duration for power quality measurements.
9. Introduced to custom power devices.

UNIT-1 Introduction to Power Quality:

Definition of Power Quality, Power Quality Terminology, Power Quality Issues, Susceptibility Criteria, Cause and Effect, power quality disturbances, power quality standards.

Harmonics: Definition & indices, harmonic sources, power system responses to harmonics, resonance, harmonic analysis methods, problems and challenges in the area of harmonics, mitigation: filter and filter design, mitigation: other methods.

UNIT-2 Sag & swell:

fault caused sags & swells, motor starting sags, calculation methods, mitigation of sag & swell disturbances

UNIT-3 Transients:

Capacitor-switching transients and lightning transients, circuit analysis of cap-

switching transients, simulation, mitigation of transients

UNIT-4 Custom Power:
Basic components and configurations, static circuit breaker, static shunt and series compensator, active harmonic filter

UNIT-5 Power Quality Measurement Devices:
Harmonic Analysers, Transient-Disturbance Analysers, Oscilloscopes, Data Loggers and Chart Recorders, True RMS Meters, Power Quality Measurements
Number of Test Locations, Test Duration, Instrument Setup, Instrument Setup Guidelines

TEXT AND REFERENCE BOOKS

1. IEEE Std. 519, "Recommended Practices and Requirements for Harmonic Control in Electric Power
2. Systems"
3. IEEE Std. 1159, "IEEE Recommended Practice for Monitoring Electric Power Quality"
4. R.C. Dugan, “Electrical Power Systems Quality”, M.F. McGranaghan
5. Jos Arrillaga, “Power System Harmonic Analysis”
6. M.H.J. Bollen, “Understanding Power Quality Problems: Voltage Sags and Interruptions, IEEE Press
7. Electric Power Quality by C. Sankaran, CRC PRESS

Teacher Assessments:

Assessments based on the following topics

1. Multiple choice objective test based on relevant topics, quiz 10Marks
2. Using power analyzer (at different industries/drives) 10 Marks

Designed By: Mr. S. M. Shinde

EE 645: INDUSTRAIAL AUTOMATION

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction to Industrial Automation and Control:

Architecture of Industrial Automation Systems, Introduction to sensors and measurement systems, Temperature measurement, Pressure and Force measurements , Displacement and speed measurement, Flow measurement techniques, Measurement of level, humidity, pH etc, Signal Conditioning and Processing

UNIT-2 Introduction to process Control:

Evolution of Process Control Concept , Definition and Types of Processes Benefits, Difficulties and Requirements of Process Control Implementation , Classification of Process Variables, Open-loop Vs Closed Loop control, Servo Vs Regulator Operation of Closed Loop System, Feedback and Feed forward Control Configuration, Steps in Synthesis of Control System, process dynamics and Mathematical Modelling, Aspects of the process dynamics, Types of dynamic processes, Common systems, Mathematical Modelling, Cascade, Feed forward, and Ratio Control, multi loop Cascade Control, Feed forward Control, Feed forward- Feedback control configuration, Ratio Controller

UNIT-3 Type of Controllers:

Introduction, PID control, Classification of Controllers, Controller Terms, Introduction, Transfer functions of closed loop, Proportional controller in closed loop, Integral controller in closed loop, Proportional-integral controller in closed loop, Proportional-derivative controller in closed loop, Proportional-integral-derivative controller in closed loop, Integral windup and Anti-windup, Comparison of various controller configurations, Controller Tuning.

UNIT-4 PLC, DCS and SCADA system:

Introduction, Basic parts of a PLC, Operation of a PLC, Basic symbols used in PLC realization, Difference between PLC and Hardwired systems, Difference between PLC and computer, Relay logic to ladder logic, Ladder commands, Examples of PLC ladder diagram realization, PLC timers, PLC counters and examples, Classification of PLCs.

History of DCS, DCS concepts, DCS hardware & software, DCS structure, Advantages and disadvantages of DCS, Representative DCS, SCADA, SCADA hardware & software,

DDC, Components and Working of DDC, Benefits of DDC, Digital controller realization, discrete domain analysis,

Networking of sensors, Actuators, controllers, canbus, profibus and modbus.

UNIT-5 Control Valves:

Introduction, Common abbreviations in the valve industry, Definitions of terms associated with valves, Control Valve characteristics, Valve classifications & types, Selection criteria for control valves, P and I diagram, Definitions of terms used in P and I diagrams, Instrument identification, Examples of P and I diagram, various automation devices used in industry, Control of Machine tools, Analysis of a control loop.

Introduction to Actuators: Flow Control Valves, Hydraulic Actuator System Principles, Components and Symbols, Pumps and Motors, Proportional and Servo Valves.

Pneumatic Control Systems, System Components, Controllers and Integrated Control Systems, Electric Drives,Energy Saving with Adjustable Speed Drives.

BOOKS:

Teacher Assessments:

Assessments based on the following topics:

1. Assignments 10 marks
2. MCQ 10 marks

EE 647: HYSTERESIS MACHINE

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction to Hysteresis Machines:
Principle of operation, Analysis of idealized radial flux machines, Analysis of idealized circumferential flux machines, Rotor hysteresis under different operating conditions, Correction for eddy currents, Influence of harmonics and slot openings

UNIT-2 Analytical Methods for Hysteresis Machines:
Special approximations to the hysteresis loop, Analysis for ideal rectangular hysteresis loops, Analysis of machines using parallelogram.

UNIT-3 Field analysis of hysteresis machines:
Fundamentals of electromagnetic fields, Analysis on the scalar magnetic potential, Analysis based on potentials $\vec{A}$ and φ

UNIT-4 Performance, testing and Design:
Performance characteristics of a three phase hysteresis motor, determination of equivalent circuit parameters, Yamada's alternative approach, Design of hysteresis machine, selection of rotor ring magnetic material, mechanical and thermal design considerations

UNIT-5 Special Machines and Materials:
Hysteresis reluctance machines, Hysteresis Permanent magnetic machines, hysteresis Machine with copper sprayed rotor ring, Axial flux hysteresis machines, Single-phase hysteresis machines, Magnetic materials

BOOKS:

TEACHER ASSESSMENTS:

Assessments based on the following topics:

1. Assignments 10 marks
2. Quiz 10 marks

Designed By :Dr. A. G. Thosar

EE 648: EMBEDDED SYSTEMS

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction to Embedded Systems:
Definition and Classification – Overview of Processors and hardware units in an embedded system – Software embedded into the system Exemplary Embedded Systems – Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits

UNIT-2 Devices and Buses for Devices Network:
I/O Devices - Device I/O Types and Examples – Synchronous - Iso-synchronous and Asynchronous Communications from Serial Devices - Examples of Internal Serial-Communication Devices - UART and HDLC - Parallel Port Devices - Sophisticated interfacing features in Devices/Ports- Timer and Counting Devices - „12C", „USB", „CAN" and advanced I/O Serial high speed buses- ISA, PCI, PCI-X, cPCI and advanced buses.

UNIT-3 Programming Concepts and Embedded Programming In C, C++:
Programming in assembly language (ALP) vs. High Level Language - C Program Elements, Macros and functions -Use of Pointers - NULL Pointers - Use of Function Calls – Multiple function calls in a Cyclic Order in the Main Function Pointers – Function Queues and Interrupt Service Routines Queues Pointers – Concepts of EMBEDDED PROGRAMMING in C++ - Objected Oriented Programming – Embedded Programming in C++, „C" Program compilers – Cross compiler – Optimization of memory codes.

UNIT-4 Real Time Operating Systems – Part I :
Definitions of process, tasks and threads – Clear cut distinction between functions – ISRs and tasks by their characteristics – Operating System Services- Goals – Structures- Kernel - Process Management – Memory Management – Device Management – File System Organization and Implementation – I/O Subsystems – Interrupt Routines Handling in RTOS, REAL TIME OPERATING SYSTEMS : RTOS Task scheduling models - Handling of task scheduling and latency and deadlines as performance metrics – Co-operative Round Robin Scheduling – Cyclic Scheduling with Time Slicing (Rate Monotonics Co-operative Scheduling) – Preemptive Scheduling Model strategy by a Scheduler – Critical Section Service by a Preemptive Scheduler – Fixed (Static) Real time scheduling of tasks - INTER PROCESS COMMUNICATION AND SYNCHRONISATION – Shared data problem – Use of Semaphore(s) – Priority Inversion Problem and Deadlock Situations – Inter Process Communications using Signals – Semaphore Flag or mutex as Resource key – Message Queues – Mailboxes – Pipes – Virtual (Logical) Sockets – Remote Procedure Calls (RPCs).

UNIT-5 Real Time Operating Systems – Part II:
Study of Micro C/OS-II or Vx Works or Any other popular RTOS – RTOS System Level Functions – Task Service Functions – Time Delay Functions – Memory Allocation

Related Functions – Semaphore Related Functions – Mailbox Related Functions – Queue Related Functions – Case Studies of Programming with RTOS – Understanding Case Definition – Multiple Tasks and their functions – Creating a list of tasks – Functions and IPCs – Exemplary Coding Steps

BOOKS

1. Rajkamal, *"Embedded Systems Architecture, Programming and Design"*, TMH, 2003 Wayne Wolf, "*Modern VLSI Design*", 2nd Edition, Prentice Hall,1998
2. Steve Heath, *"Embedded Systems Design"*, Second Edition-2003, Newnes, 3. David E.Simon, *"An Embedded Software Primer"*, Pearson Education Asia, First Indian Reprint 2000
3. Wayne Wolf, "Computers as Components; Principles of Embedded Computing System
   Design", Harcourt India, Morgan Kaufman Publishers, First Indian Reprint

Teacher Assessments:

Assessments based on the following topics:

1. Assignments 10 marks
2. MCQ 10 marks

Designed By: Mrs. S. S. Kulkarni

EE 649: VERY LARGE SCALE INTEGRATION

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 MOS Technology and VLSI, Process parameters and considerations for BJT, MOS and CMOS,
Electrical properties of MOS circuits and Device modeling.

UNIT-2 MOS Layers, Stick diagram, Layout diagram, Propagation delays, Examples of combinational logic design, Scaling of MOS circuits.

UNIT-3 Programmable Logic Array (PLA) and Finite State Machines, Design of ALUs, Memories and Registers.

UNIT-4 Introduction to Analog VLSI, Realization of Neural Networks and Switched capacitor filters, Sub-micron technology and GA As VLSI technology.

UNIT-5 VHDL background and basic concepts, Structural specifications of hardware design organization and parameterization.

BOOKS

1. Douglas A. Pucknell and Kamran Eshraghian, “Basic VLSI Design Systems and Circuits”, Prentice Hall of India Pvt Ltd.,1993
2. Wayne Wolf, “Modern VLSI Design”, 2nd Edition, Prentice Hall,1998
3. Amar Mukherjee,” Introduction to NMOS and CMOS VLSI System Design”, Prentice Hall, 1986.
4. Randall .L.Geiger and P.E. Allen, “VLSI Design Techniques for Analog and Digital Circuits”, McGraw-Hill International Company, 1990.
5. Fabricious. E, “Introduction to VLSI Design” , McGraw Hill, 1990.
6. Navabi .Z., “ VHDL Analysis and Modeling of Digital Systems” , McGraw Hill, 1993.
7. Mohmmed Ismail and Terri Fiez, “Analog VLSI Signal and Information Processing”, McGraw-Hill,1994
8. Peter J. Ashenden, “The Designer's Guide to VHDL”, Harcourt Asia Private Limited & Morgan Kauffman, 1996.

Teacher Assessments:

3. Design a system to demonstrate application of VLSI using software 05 Marks

4. To develop Miniproject 05 Marks
5. Design prototype model and its simulation 10 Marks

Designed By :Mrs. S. S. Kulkarni

EE 549: Solar Energy Systems

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

Prerequisites:

Course Educational Objectives:

To familiarize students with the characteristics of solar radiation, its global distribution, and conversion methods of solar energy to heat and power

Course Outcomes:

Upon successful completion of the course the students will be able to

Understand and apply

1. The characteristics and world distribution of solar radiation.
2. The solar radiation and measurement techniques.
3. The methods of calculation of solar radiation availability at a givenlocation.
4. The fundamentals of thermal and direct conversion of solar energy topower.

UNIT-1 Introduction to Solar Energy Historical Perspective:
Energy Use in the India, Solar Energy; Obstacles and Outlook The Solar Spectrum, The Earth's Orbit, Altitude Angle of the Sun at Solar Noon, Solar Position at Any Time of Day, Sun Path Diagrams for Shading Analysis, Solar Time and Civil (Clock) Time, Sunrise and Sunset, Clear Sky Direct-Beam Radiation, Solar Radiation Measurements, Average Monthly Insolation

UNIT-2 PN junction solar cell generation of photo voltage:
light generated current, I-V equation of solar cell Solar cell characteristics, cell parameters short circuit current, open circuit voltage, fill factor, efficiency . The PV I–V Curve under Standard Test Conditions (STC), Impacts of Temperature and Insolation on I –V Curves, Shading Impacts on I–V Curves

UNIT-3 Crystalline Silicon Technologies:
Thin-Film Photovoltaic Generic advantages of thin film technologies, materials for thin film technologies, common features of thin film technologies, amorphous Si solar cell, Cadmium Telluried solar cell Current–Voltage Curves for Loads,

UNIT-4 Concentrator PV Cell systems:
optics for concentrator, V-trough concentrator modules, compound parabolic trough concentrator, parabolic reflector, Fresnel's lens concentrator, tracking requirements of CPV Grid-Connected Systems, Grid-Connected PV System Economics, Stand-Alone PV Systems, PV-Powered Water Pumping

UNIT-5 Devices for thermal collection and storage , Liquid flat plate collectors, Solar air heaters, central receiver collector, solar pond, Solar distillation

TEXT AND REFERENCE BOOKS

1. Renewable and Efficient Electric Power Systems, Gilbert M. Masters, Wiley Interscience publication

2. Solar Photovoltaic's Fundamentals,Technologies and Applications, Chetan Singh Solanki, Second edition,PHI Publication

3. "Principle of Solar Engineering" by D. Yogi Goswami, Frank Kreith and Jan F. Kreider, 2nd ed. Taylor & Francis, 2000, ISBN-10: 1-56032-714-6, ISBN -13:978-156032-714-1

4. Power Generation Renewables by PEP (Professional Engineering Publishers) Wiley publications

5. "Modeling Daylight Availability and Irradiance Components from Direct and Global Irradiance" by R. Perez, P. Ineichen, R. Seals, J. Michalsky and R. Stewart, Solar Energy 44 (5) pp. 271-289

6. Solar Energy principles of thermal collection and storage, S.P.SUKHATME &J.K.NayakThird edition Tata McGrow Hill publication

Teacher Assessments:

Assessments based on the following topics,

Policy initiatives regarding solar, Concerns about Global Warming, visits to installed sites, working Models of tracking system, Numerical from exercise

Designed By: Mr. S. M. Shinde

EE 561: SMART GRID TECHNOLOGIES & APPLICATIONS

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction to Smart Grid**:**

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid

UNIT-2 Smart Grid Technologies:

Part 1:Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit

UNIT-3 Micro grids and Distributed Energy Resources:

Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Plastic & Organic solar cells, Thin film solar

Cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources.

UNIT-4 Power Quality Management in Smart Grid:

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring,

Power Quality Audit.

UNIT-5 Information and Communication Technology for Smart Grid:

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

BOOKS

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley
4. Jean Claude Sabonnadiere, NouredineHadjsaid, “Smart Grids”, Wiley Blackwell
5. Tony Flick and Justin Morehouse, “Securing the Smart Grid”, Elsevier Inc. (ISBN: 978-1-59749-570-7)

Teacher Assessments:

Assessments based on the following topics:

1. Assignments 10 marks
2. MCQ 10 marks

Designed By: Mrs. A. A. Bhole

EE 661: FINITE ELEMENT METHODS

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction:
Finite Element Method for solving field problems. Stress and Equilibrium. Strain – Displacement relations. Stress – strain relations. One Dimensional problem: Finite element modeling coordinates and shape functions. Potential Energy approach: Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

UNIT-2 Analysis of Beams:
Element stiffness matrix for two node, two degrees of freedom per node beam element.

UNIT-3 Finite element modelling:
Two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Finite element modeling of Ax symmetric solids subjected to Ax symmetric loading with triangular elements. Two dimensional four nodded isoperimetric elements and numerical integration.

UNIT-4 Steady state heat transfer analysis:
One dimensional analysis of a fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion.

UNIT-5 Dynamic Analysis:
Formulation of finite element model, element matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam application to electrical machine design.

BOOKS

1. Chandraputla, Ashok and Belegundu, "*Introduction to Finite Elements in Engineering*" , Prentice Hall
2. S.S. Rao, "*The Finite Element Methods in Engineering*" , Pergamon
3. J.N. Reddy ,"*An introduction to Finite Element Method*" , Mc Graw Hill
4. Alavala, " *Finite Element Methods*", TMH
5. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom ,"*The Finite Element Method for Engineers"* , John Wiley & sons (ASIA) Pte Ltd.
6. C.S.Krishnamoorthy, "*Finite Element Analysisthoery and programming*", TMH,1987

Teacher Assessments:

Assessment will be based on following:

1. Write algorithm showing use of FEM for real time application 10 Marks
2. Develop FEM model for real time any application 10 Marks

Designed By :Mrs. S. S. Kulkarni

EE 662: ENGINEERING MATERIALS

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Conductivity of Metals:
Structure of the Atom, Crystallinity , Anisotropy Factors affecting the resistivity of electrical materials , Motion of an electron in an electric field , Fermi- Dirac distribution , Photo- electric emission, Superconductivity, Electrical conducting materials, Thermoelectric effects, Operation of thermo-couple

UNIT-2 Dielectric Properties:
Effect of a dielectric on the behaviour of a capacitor, polarization, Frequency dependence of electronic polarizability, Dielectric losses, Significance of the loss tangent, Dipolar relaxation, Frequency and temperature dependence of the dielectric constant of polar dielectrics, Dielectric properties of polymeric systems, insulating materials, ferroelectricity, piezoelectricity

UNIT-3 Magnetic properties of Materials:
Classification of magnetic materials, The origin of permanent magnetic dipoles, Diamagnetism, Paramagnetism, ferromagnetism, The origin of ferromagnetic dipoles, ferromagnetic domains, the magnetic curve, Magnetization curve, the hysterisis loop, magnetostriction, factors of affecting permeability and hysterisis loss, common magnetic materials, anti-ferromagnetic , ferromagnetic, magnetic resonance

UNIT-4 Semi-conductors:
Energy bands in solids, the Einstein relation, hall effect, electrical conductivity of doped materials, materials for fabrication of semi-conductor devices,
Measurement of electrical and magnetic properties : conductivity measurements, dielectric measurements, magnetic measurements, Measurement of semi-conductor parameters
Conduction in liquids:
faraday's law of electrolysis, ionic velocities, chemical cells and conventration cells, irreversible and reversible cells, practical cell, electrolytic depositions, corrosion of metals, nature of corrosion
Optical properties of solids**:**
Photo-emission, photo-emission materials and types of photo-cathodes, definitions of terms, electroluminescence, electroluminescent panels.

UNIT-5 Materials for electric components**:**
Introduction, resistors, capacitors, inductors, relays Mechanical properties The stress/strain relationship, plastic behaviour, block slip theory, hardening, ductility

BOOKS

1. Indulakar," Engineering Material", S. Chand Publications

2. M F Ashby, David R H Jones, “Engineering Materials”.
3. Mathew Philip, William Bolton, “Technology of Engineering Materials”.
4. J. A. Charles, F A. A. Crane, J A G Furness “Selection and use of Engineering Materials”.
5. Joachim, Rosler, Harald, Harders& Martin Baker “Mechanical Behaviour of Engineering Materials”
6. Krishan Kumar Chawla, “Composite Materials: Science & Engineering

Teacher Assessments:

Assessment will be based on following:

6. Assignments 10 Marks
7. MCQ 10 Marks

Designed By: Mr. V. P. Dhote

EE 548: POWER SYSTEM RELIABILITY

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Generating system reliability analysis – I**:**
Generation system model, capacity outage probability tables, Recursive relation for capacitive model building, sequential addition method, unit removal, Evaluation of loss of load and energy indices

UNIT-2 Generating system reliability analysis – ii:
Frequency and Duration methods, Evaluation of equivalent transitional rates of identical and non-identical units, Evaluation of cumulative probability and cumulative frequency of non- identical generating units – 2, level daily load representation, merging generation and load models

UNIT-3 Basic concepts of risk indices:
PJM methods, security function approach, rapid start and hot reserve units, Modelling using STPM approach. Bulk Power System Reliability Evaluation: Basic configuration, conditional probability approach, system and load point reliability indices, weather effects on transmission lines, Weighted average rate and Markov model, Common mode failures.

UNIT-4 ANALYSIS Probability array method:
Two inter connected systems with independent loads, effects of limited and unlimited tie capacity, imperfect tie, Two connected Systems with correlated loads, Expression for cumulative probability and cumulative frequency. Distribution System Reliability Analysis – I (Radial configuration): Basic Techniques, Radial networks, Evaluation of Basic reliability indices, performance indices, load point and system reliability indices, customer oriented, loss and energy oriented indices

UNIT-5 Basic techniques:
Inclusion of bus bar failures, scheduled maintenance, temporary and transient failures, weather effects, common mode failures, Evaluation of various indices. Substations and Switching Stations: Effects of short-circuits, breaker operation, Open and Short-circuit failures, Active and Passive failures, switching after faults, circuit breaker model, preventive maintenance, exponential maintenance times.

BOOKS:

1. Reliability Evaluation of Power Systems by Roy Billinton and Ronald N. Allan, Plenum press, New York and London (Second Edition), 1996. 2. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978. (First Edition

Teacher Assessments:

Assessment will be based on the following:

1. Assignment 10 Marks
2. MCQ 10 Marks

EE 664: DSP PROCESSOR

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Introduction to programmable DSPs:
Multiplier and Multiplier Accumulator (MAC), Modified bus structure and memory access, multiple access memory, Multi-ported memory, VLIW Architecture, Pipelining, special addressing modes in P-DSPs, On-Chip Peripherals.

UNIT-2 TMS320C5X:
TMS320C5X architecture, TMS320C5X Assembly language instruction, Instruction pipeline in C5X, Application programs in C5X

UNIT-3 TMS320C3X:
TMS320C3X architecture, Addressing modes and assembly language instructions of 'C3X, Application programs in C3X

UNIT-4 TMS320C54X:
TMS320C54X architecture, Addressing modes and assembly language instructions, Application programs in C54X

UNIT-5 TMS320C6X and Motorola DSP563XX:
TMS320C6X architecture, Addressing modes and assembly language instructions, Application programs in C54X, an overview of Motorola DSP563XX processor

BOOKS:

1.

Teacher Assessments:

Assessments based on the following topics:

1. Assignments 10 marks
2. MCQ 10 marks

Designed By :Dr. A. G. Thosar

EE 665: OPTIMAL CONTROL SYSTEM

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 General Mathematical Procedures:
Introduction, Formulation of the Optimal Control Problem, The Characteristics of the Plant, The Requirements Made Upon the Plant, Minimum Time Problem, Minimum Energy Problem, Minimum Fuel Problem, State Regulator Problem, Output Regulator Problem, Tracking Problem, The Nature of Information about the Plant Supplied to the Controller

UNIT-2 Calculus of Variations:
Minimization of Functions, Minimization of Functional, Functional of a Single Function, Functional Involving an Independent Functions, Constrained Minimization, Formulation of Variation Calculus Using Hamiltonian Method, Minimum Principle:
Control Variable Inequality Constraints, Control and State Variable Inequality Constraints

UNIT-3 Dynamic Programming:
Multistage Decision Process in Discrete – Time, Principle of Causality, Principle of Invariant Imbedding, Principle of Optimality, Multistage Decision Process in Continuous – Time Hamilton Jacobi Equation

UNIT-4 Numerical Solution of Two- Point Boundary Value Problem:
Minimization of Functions, The Steepest Descent Method, The Fletcher – Powell Method, Solution of Two Point Boundary Value Problem

UNIT-5 Optimal Feedback Control:
Introduction, Discrete Time Linear State Regulator, Continuous Time Linear State Regulator, Time Invariant Linear State Regulators, Continuous – Time Systems, Discrete Time Systems, Discretization of Performance Index. Numerical Solution of the Riccati Equation:Direct Integration, A Negative Exponential Method, An Iterative MethodUse of Linear State Regulator results to Solve Other Linear Optimal Control Problems. Output Regulator problem, Linear Regulator with a Prescribed Degree of Stability, A Tracking Control Scheme, Discrete Time Extensions

BOOKS:

Teacher Assessments:

Assessments based on the following topics:

1. Assignments 10 marks
2. MCQ 10 marks

Designed By :Dr. A. G. Thosar

EE 666: ELECTRIC TRACTION

(Elective)
(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Electric Traction- Principle and History:
Systems of traction, The Indian Scenario of Electric traction, Present day State of art Electric traction as a Viable Transport Strategy for the 21st century, Advantages of Electric Traction over other systems of traction, Choice of traction system - Diesel-Electric or Electric.
Mechanics of train movement
Speed - time curve for train movement, Requirement of tractive effort and T-N curve of a typical train load, Specific energy consumption & Factors affecting SEC Adhesion & Coefficient of adhesion, Suspension and mechanism of torque transmission, Concept of Weight Transfer & Effect of un-sprung mass and wheel diameter

UNIT-2 Traction Motor Drives- Principles and gear:
Type of traction motor best suited for traction duties,Available motor characteristics and their suitability for traction duties, Optimization of design and construction features for improved power to weight ratio, Power Factor and Harmonics, Tractive Effort and Drive Ratings, Important Features of Traction Drives, conventional DC and AC Traction drives, Semiconductor Converter Controlled Drives, DC Traction using Chopper Controlled Drives, Poly phase AC motors for Traction Motors, DC /AC Traction employing Poly-phase motors, Diesel Electric Traction, Traction control of DC locomotives and EMU's, Traction control system of AC locomotives, Control gear, PWM control of induction motors, Power & Auxiliary circuit equipment (Other than traction motors)

UNIT-3 Protection of Electric Locomotive Equipment and Circuits (Safety considerations and monitoring):
Broad strategy for protection, Surge protection, Overload protection of main power circuits, Earth fault protection of power of auxiliary circuits, Protection from over-voltage and under-voltage, Differential protection of traction circuits, Protection against high and low air pressure in the compressed air circuit, Temperature monitoring, Protection of transformer by Bucholz relay, Protection against accidental contact with HT equipment Protection against fires

UNIT-4 Electric Traction Sub-Systems (Overhead Equipment):
Overhead Equipment (OHE),Sectionalizing, Bonding of Rails and Masts, Materials Employed in OHE
Electric Traction Sub-Systems (Power Supply Installations):
Lay out design of 137/25 KV Traction Substation/ Protection, Booster Transformers and Return Conductor, Salient 2x25 Kv AC System/ SCADA

UNIT-5 Railway Signaling:

Block Section Concept, Track Circuits ,Interlocking Principle, Train speed and signaling, Solid state Interlocking, Automatic Warning Systems ,CAB signaling, Signaling level crossing

BOOKS

1. Upadhayay J. & Mahindra S.N., "*Electric Traction",* Allied Publishers Ltd., 1st Ed.
2. Rao P.S., "*Principle of 25 KV Overhead Equipments.R.(Nasik)",*Printpack Pvt Ltd,, 1st Ed,
3. Gopal K Dubey, "*Fundamentals of Electric Drives*" , Narosa Publishing.
4. Partab ,"*Modern Electric Traction*", Dhanpat Rai & Sons

Teacher Assessments:

Assessments based on the following topics:

1. Assignments 10 marks
2. MCQ 10 marks

Designed By: Mrs.S.S.Kulkarni

EE 563: ILLUMINATION ENERGY

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

UNIT-1 Importance of Lighting in Human Life:

Optical systems of human eye ,Dependence of human activities on light, performance characteristics of human visual system, Artificial lighting as substitute to natural light, Ability to control natural light,

Construction and working principles of spectro-radiometer, spectrophotometer and colorimeter. Retro reflection & its application.

Colorimetric-Different colour specification systems and their limitations. Measurement of CRI, CRI of radiation due to multiple sources. Pigment colour and mixing of pigments in paint industries

UNIT-2 Light Source:

Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, LEDs characteristics, features and applications, LASERS, characteristics, features and applications, non-lighting lamps, Induction lamps. Optical fibre, its construction as a light guide, features and application

UNIT-3 Photometric Control of Light Sources and their Quantification:

Luminaries design considerations, optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting fixtures according to installation type, types of lighting fixtures according to photometric usages, ingress protection code,luminary's standard. Indian standard recommendations.

UNIT-4 Factors of Good Lighting Design:

Indoor Lighting Design: Zonal cavity method for general lighting design, coefficient of Utilization determination for zonal cavities and different shaped ceilings. Using COU (coefficient of utilization), using beam angles and polar diagrams, glare calculations. Typical applications: office, educational facility, theatre, residential, hospital. Indian Standard recommendation for indoor lighting, selection criteria for selection of lamps and luminaries, design consideration and design procedure. (Problems on COV, beam angles and polar diagrams).

Designing problem and solution and designing documentation. Exterior lighting system- Road lighting system and highway lighting system.

UNIT-5 Outdoor Lighting Design:

Road classifications according to BIS, pole arrangement,

terminology, lamp and luminaries selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method. Energy Efficient Lighting: Comparison between different light sources, comparison between different control gears, overcoming problems in energy efficient lighting, payback calculation, life cycle costing, (problems on payback calculations, life cycle costing). Solar Lighting: Day Lighting, Photovoltaic Lighting

Emergency Lighting: Central Systems, Standalone systems Cold Lighting: Concept, Method of generation – Optical Fiber cable (OFC), filters, Application

BOOKS

1. H. S. Mamak, "Book on Lighting", Publisher International lighting Academy
2. Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to Lasers"
3. M. A. Cayless, A. M. Marsden, "Lamps and Lighting".
4. "BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", ManakBhavan, New Delhi
5. D. C. Pritchard, "Lighting", 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422-0 Elmer, "Design of Reflectors"
6. "IES Lighting Handbook", (Reference Volume 1984), Illuminating Engineering Society of North America
7. "IES Lighting Handbook", (Application Volume 1987), Illuminating Engineering Society of North America

Teacher Assessments:

Assessments based on the following topics:

1. Assignments 10 marks
2. MCQ 10 marks

Designed By: Mr. P. S. Swami

EE 566: WIND ENERGY SYSTEMS

(Elective)

(Implemented from 2015)

Teaching Scheme		**Evaluation Scheme**	
Lectures	03Hrs/Week	Test	20 Marks
Total Credits	03	Teacher Assessment	20 Marks
		End-Semester Examination	60 Marks

Prerequisites:

Course Educational Objective:

The objectives of the course are to

Course Outcomes:

Students will be able to

UNIT-1 Historical development of wind power:
types of wind turbines , aerodynamic construction of blade, power in the wind and Betz's limit, Impact of tower height, maximum rotor efficiency, Altitude and temperature correction for air density , Multiple gear box

UNIT-2 Wind turbine generators:
synchronous generator, The asynchronous Induction generator, Speed control for maximum power, importance of variable rotor speeds, pole changing induction generator, variable slip induction generator, indirect grid connection system

UNIT-3 Discrete wind histogram:
wind power probability density function, waybill and Rayleigh statics, Estimates of wind turbine energy, Annual energy calculations, specific wind turbine performance calculations

UNIT-4 Idealized wind turbine power curve:
optimizing rotor diameter and generator rated power, wind speed cumulative distribution function using real power curves with weibull characteristics

UNIT-5 Capacity factor to estimate energy produced:
capital cost and annual cost, Annualized cost of electricity from wind turbines, environmental impacts of wind turbine, wind farms

TEXT AND REFERENCE BOOKS

1) Renewable and Efficient Electric Power Systems, Gilbert M. Masters, Wiley Interscience publication

Teacher Assessments:

Assessments based on the following topics,

Policy initiatives regarding Use of renewable energy sources, Concerns about Global Warming, visits to installed sites, working Models, Numerical from exercise

Designed By: Mr. S. M. Shinde