

**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)					
			L	T	P		Theory			Term Work	Practical & Viva-voce	Total
							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
<b>A]</b>	<b>Total of Semester I</b>		<b>15</b>	<b>03</b>	<b>10</b>	<b>24</b>	<b>100</b>	<b>100</b>	<b>300</b>	<b>75</b>	<b>25</b>	<b>600</b>

**SEMESTER-II**

THEORY COURSES												
S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)					
			L	T	P		Theory			Term Work	Practical & Viva-voce	Total
							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>B]</b>	<b>Total of Semester II</b>		<b>17</b>	<b>00</b>	<b>12</b>	<b>24</b>	<b>130</b>	<b>130</b>	<b>240</b>	<b>100</b>	<b>00</b>	<b>600</b>
<b>Total of Semester (A+B)</b>			<b>32</b>	<b>03</b>	<b>22</b>	<b>48</b>	<b>230</b>	<b>230</b>	<b>540</b>	<b>175</b>	<b>25</b>	<b>1200</b>

\* Students will complete their in-plant training in industries for maximum one month and minimum one week during summer vacation (after 2<sup>nd</sup> 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)					
			L	T	P		Theory			Term Work	Practical & Viva-voce	Total
							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
<b>C] Total of Semester III</b>			<b>06</b>	<b>01</b>	<b>20</b>	<b>17</b>	<b>40</b>	<b>40</b>	<b>120</b>	<b>50</b>	<b>00</b>	<b>250</b>
SEMESTER IV												
1	EE 676	Dissertation Phase-II			20	10				25	75	100
2	EE 677	Comprehensive viva-voce				01					50	50
<b>D] Total of Semester IV</b>			<b>00</b>	<b>00</b>	<b>20</b>	<b>11</b>	<b>00</b>	<b>00</b>	<b>00</b>	<b>25</b>	<b>125</b>	<b>150</b>
<b>Total of All Semester(A+B+C+D)</b>			<b>38</b>	<b>04</b>	<b>62</b>	<b>76</b>	<b>270</b>	<b>270</b>	<b>660</b>	<b>250</b>	<b>150</b>	<b>1600</b>

*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**

Lectures	03Hrs/Week
Tutorial	01Hrs/week
Total Credits	04

**Evaluation Scheme**

Test	20 Marks
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", Wiley

**Teacher Assessment:**

Assessments will be based on following -

1. Assignment
2. MCQ

10 Marks

10 Marks

**Designed By : Mr.S. S. Dhamse**

**EE 643: Modern Control Systems**  
(Compulsory)  
(Implemented from 2015)

<b>Teaching Scheme</b>		<b>Evaluation Scheme</b>	
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:  
Introduction to 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
2. MCQ

10Marks  
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, Control principle 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

Practical 04Hrs/Week  
Total Credits 02

### Evaluation Scheme

Term work 25 Marks  
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

Practical            04Hrs/Week  
Total Credits        02

### Evaluation Scheme

Term work

25 Marks

### 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, diagonalisation of the system
8. Study of magnetic levitation 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**

Practical            02Hrs/Week  
Total Credits        02

**Evaluation Scheme**

Term work

25 Marks

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

Lectures 03Hrs/Week  
Total Credits 03

### Evaluation Scheme

Test 25 Marks  
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](http://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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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 and flux 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
2. MCQ

10 Marks

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. Fitzgerald, 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, or any 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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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 Schaffer, "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

Lectures	02Hrs/Week
Total Credits	02

### Evaluation Scheme

Test	25 Marks
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**

Lectures            04Hrs/Week  
Total Credits        02

**Evaluation Scheme**

Term work

25 Marks

**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 window Kaiser 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**

Practical 02Hrs/Week  
Total Credits 01

**Evaluation Scheme**

Term work

25 Marks



**EE 672:SEMINAR-II**  
(Compulsory)  
(Implemented from 2015)

**Teaching Scheme**

Lectures 02Hrs/Week  
Total Credits 02

**Evaluation Scheme**

Term work

25 Marks

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**

Lectures 18Hrs/Week  
Total Credits 09

**Evaluation Scheme**

Term work 50 Marks

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**

Total credit      01

**Evaluation Scheme**

Practical/viva-voce

50 Marks



## EE 674: RENEWABLE ENERGY TECHNOLOGY

(Compulsory)

(Implemented from 2015)

Teaching Scheme		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", Wiley Publications.
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

Practical	20Hrs/Week
Total Credits	10

### Evaluation Scheme

Term work	25Marks
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**

Lectures 04Hrs/Week  
Total credits 04Hrs/Week

**Evaluation Scheme**

Test 20 Marks  
Teacher Assessment 20 Marks  
End Semester Exam 60 Marks

**ME (Electrical Machines and Drives)  
Electives**

**EE645: POWER QUALITY**  
(Elective)  
(Implemented from 2015)

**Teaching Scheme**

Lectures	03Hrs/Week
Total Credits	03

**Evaluation Scheme**

Test	20 Marks
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 Systems"
2. IEEE Std. 1159, "IEEE Recommended Practice for Monitoring Electric Power Quality"
3. R.C. Dugan, "Electrical Power Systems Quality", M.F. McGranaghan
4. Jos Arrillaga, "Power System Harmonic Analysis"
5. M.H.J. Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions, IEEE Press
6. 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: INDUSTRIAL AUTOMATION

(Elective)

(Implemented from 2015)

### Teaching Scheme

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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  $\varphi$

#### 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



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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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
5. Design prototype model and its simulation

05 Marks

10 Marks

**Designed By :Mrs. S. S. Kulkarni**



## **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.Nayak Third edition Tata McGraw 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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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 noded 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 Analysis theory 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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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 hysteresis loop, magnetostriction, factors of affecting permeability and hysteresis 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 concentration 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**



**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**

Lectures	03Hrs/Week
Total Credits	03

**Evaluation Scheme**

Test	20 Marks
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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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 Method Use 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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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,, 1<sup>st</sup> 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

Lectures	03Hrs/Week
Total Credits	03

### Evaluation Scheme

Test	20 Marks
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

Lectures 03Hrs/Week  
Total Credits 03

### Evaluation Scheme

Test 20 Marks  
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**