GOVT. COLLEGE OF ENGINEERING
AURANGABAD

CURRICULUM

M. TECH. (ELECTRICAL MACHINES & DRIVES)

Department of Electrical Engineering
2018-19

GOVERNMENT COLLEGE OF ENGINEERING, AURANGABAD

(An Autonomous Institute of Government of Maharashtra)

Department of Electrical Engineering

Teaching and Evaluation Scheme

M. Tech. (Electrical Machines & Drives) Full Time CBCS Pattern

(2018-19 onwards)

SEMESTER-I

THEORY COURSES												
S. No.	Course Code	Subject	Scheme of			Total Credits	Scheme of Evaluation (Marks)					
			L	T	P		Theory			Term Work	Practical/ Viva-voce	Total
							Test	TA	ESE			
1	EE52001	Advanced Power Electronics	03	0		03	20	20	60	-	-	100
2	EE52002	Electrical Machine Modeling and Analysis	03	0		03	20	20	60	-	-	100
3	*	Program Elective -I	03	0	0	03	20	20	60	-	-	100
4	*	Program Elective-II	03	0	0	03	20	20	60	-	-	100
5		Research Methodology	02	0	0	02	20	20	60	-	-	100
LABORATORY COURSES												
6	EE52003	Simulation Laboratory-I	-	-	04	02	-	-	-	25	25	50
7	EE52004	Hardware Lab	-	-	04	02	-	-	-	25	25	50
		Audit Course	2									
		TOTAL	**16**	**0**	**08**	**18**	**100**	**100**	**300**	**50**	50	600

SEMESTER-II

THEORY COURSES												
S. No.	Course Code	Subject	Scheme of			Total Credits	Scheme of Evaluation (Marks)					
			L	T	P		Theory			Term Work	Practical/ Viva-voce	Total
							Test	TA	ESE			
1	EE52005	Advanced Control Systems	03	0	-	03	**20**	20	60	-	-	100
2	EE52006	Advanced Electric Drives	03	0	-	03	**20**	20	60	-	-	100
3	*	Program Elective-III	03	0	-	03	20	20	60	-	-	100
4	*	Program Elective-IV	03	0	-	03	20	20	60	-	-	100
5	*	Program Elective-V	03	0	-	03	20	20	60	-	-	100
LABORATORY COURSES												
6	EE52007	Simulation Laboratory-II	-	-	04	02	-	-	-	25	25	50
7	EE52008	Lab Electric Drives	-	-	04	02	-	-	-	25	25	50
8	EE52009	Mini Project with Seminar	-	-	04	02	-	-	-	50	50	100
9	#	Internship/ Industrial Training	-	-	-	-	-	-	-	---	-	-
		TOTAL Semester II	**15**	**0**	**12**	**21**	**100**	**100**	**300**	**100**	**100**	**700**
		Total First Year	**33**	**11**	**08**	**48**	**220**	**220**	**660**	**100**	**100**	**1300**

L-Lectures, T-Tutorials, P-Practicals, TA-Teacher Assessment, ESE-End-Semester Examination

Approved in XIX th Academic Council, dated 27/07/2018

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	**	Open Elective	03	0		03	20	20	60		-	100
LABORATORY COURSES/Seminars etc.												
1	EE62001	Dissertation-I			20	10				50	50	100
		TOTAL Semester III	**03**	**0**	**20**	**13**	**20**	**20**	**60**	**50**	**50**	**200**

SEMESTER-IV

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	EE62002	Dissertation-II			32	16				100	150	250
		TOTAL SECOND YEAR	**03**	**0**	**52**	**29**	**20**	**20**	**60**	**150**	**200**	**450**
		GRAND TOTAL	**34**	**0**	**72**	**68**	**220**	**220**	**660**	**300**	**350**	**1750**

**** Students can choose online course such as MOOCs/SWAYAM/NPTL etc in place of open elective with prior intimation and approval of department**

 # Internship/Industrial Training: The student has to undergo internship/industrial training of minimum one month after second semester. Student has to give presentation on the same in subsequent semester.

	*List of Program Electives I, II, III , IV and V				
	Group A	**Group B**	**Group C**	**Group D**	**Group E**
Program Elective I	EE52010 Fuzzy-Logic & Artificial Neural Networks	**EE51012 Illumination Engineering**	EE52011 Special Machines	EE52012 Industrial Automation & Control	EE52013 Reliability And Conditioning Monitoring
Program Elective II	EE52014 Microcontroller and Its Application	**EE51015 Wind Energy Systems**	EE52015 Electrical Machine Design	EE52016 Digital Control System	**EE51014 Smart Grid Technology**
Program Elective III	**EE51021 Power Quality**	**EE51018 Solar Energy Systems**	EE52017 Electrical Drives Application	**EE51017 Life Estimation of Power Equipments**	**EE51006 H.V.D.C and FACTS**
Program Elective IV	EE52018 Digital Signal Processing	EE52019 Optimization Techniques	EE52020 Electric Traction	EE52021 Optimal Control Systems	**EE51020 Power System Reliability**
Program Elective V	(CSXXXXX) Internet Of Things	EE52022 Biomedical Instrumentation	EE52023 Electric Vehicle	EE52024 Embedded Systems	**EE51023 Engineering Materials**

****Open Elective offered by Electrical Department**

EE61001	**Renewable Energy Technology (Offered by Electrical Engineering Department)**

Approved in XIX th Academic Council, dated 27/07/2018

EE52001 : ADVANCED POWER ELECTRONICS			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Test	: 20 Marks
Tutorial	: 0 Hrs/Week	Teachers Assessment	: 20 Marks
Credits	: 03	End Semester Exam	: 60 Marks

Course Description:

Advanced Power Electronics is a one-semester course. It is advance course related to power electronics.

Course Objectives:

The objectives of the course are to-
1. Introduce advanced power semiconductor devices
2. Understand operation of DC to DC converters
3. Study and analyze DC-AC converters
4. Study and analyze AC-AC converters
5. Study power supplies and protection circuits

Course Outcomes:
After completing the course, students will able to:

CO1	Describe structure, characteristics, and applications of advanced power semiconductor devices
CO2	Explain and analyze DC-DC converters
CO3	Explain and analyze DC-AC converters and various control techniques
CO4	Explain and analyze AC-AC converters
CO5	Discuss types of power supplies, protection circuits and thermal modeling

Detailed Syllabus:

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 cycloconverters
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

Approved in XIXth Academic Council, dated 27/07/2018

Text 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 any one or two of the following components -

1. Assignment
2. MCQ
3. PPT
4. Surprise Test

EE52002 : ELECTRICAL MACHINE MODELING AND ANALYSIS			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Test	: 20 Marks
Tutorials	: 0 Hrs/Week	Teachers Assessment	: 20 Marks
Credits	: 03	End Semester Exam	: 60 Marks

Course Description:

Electrical Machines modeling and Analysis is a one-semester course this student can opt this course as professional elective.

Course Objective:

The objectives of the course are to master the various fundamentals, machine design, machine modeling of various types of electrical machines. This will help you to gain knowledge and to do research in the area of electrical machine modeling.

The main objective of the course is to:

1. Know the concepts of generalized theory of electrical machines.
2. Model and analysis the electrical machines with voltage, and torque equations.
3. Known the steady state and transient behavior of the electrical machines.
4. Understand the dynamic behavior of the DC/AC, special machines machines.
5. Learn the issues affecting the behavior of different types machines such as sudden application of loads, short circuit etc.

Course Outcomes:

After completing the course, students will be able to:

CO1	The basic concepts of AC/ DC machine modeling.
CO2	The dynamic modeling and phase transformation
CO3	Analyze various methodologies in DC machine modeling.
CO4	Understand the modeling of induction, synchronous machine modeling
CO5	The performance and dynamic modeling of BLDC,PMSM machines

Detailed Syllabus:

Unit 1	Basic concepts of Modeling: Basic Principles of Electrical Machine Analysis, Need of modeling, Introduction to modeling of electrical machines
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	Modeling 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	Three phase Induction Machines: Modeling 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	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

Approved in XIX[th] Academic Council, dated 27/07/2018

Text and Reference 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 – Modeling, Analysis and Control", PHI Learning Private Limited, New Delhi, 2011.

Teacher's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Teaching Strategies:

The teaching strategy planned through the lectures, and team based home works. Exercises assigned weekly to stimulate the students to actively use and revise the learned concepts, which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes emphasized

Special Instructions if any: Nil

Approved in XIXth Academic
Council, dated 27/07/2018

Approved in XIXth Academic
Council, dated 27/07/2018

***RESEARCH METHODOLOGY		
Teaching Scheme	**Examination Scheme**	
Lectures : 02 Hrs/Week	Test	: 20 Marks
Tutorial : 0 Hrs/Week	Teachers Assessment	: 20 Marks
Credits : 03	End Semester Exam	: 60 Marks

*** For syllabus refer institute website

EE52003: SIMULATION LABORATORY- I		
Teaching Scheme	Examination Scheme	
Practical : 04 Hrs/Week	Term Work	: 25 Marks
Credits : 02	Viva-voce	: 25 Marks
	Total	: 50 Marks

Term Work Shall consist of record of minimum eight experiment/assignment using engineering computation software such as MATLAB, PSCAD, ETAP with moderate to high complexity.

Approved in XIXth Academic
Council, dated 27/07/2018

EE52004: HARDWARE LABORATORY			
Teaching Scheme		**Examination Scheme**	
Practical	: 4 Hrs/Week	Term Work	: 25Marks
Total Credits	: 2	Practical Exam/Oral	: 25 Marks
		Total	: 50 Marks

Course Objectives

The objectives of the course are to-

1. Expose the students to experimentation on different power electronics converters.
2. Develop the skills related to design of power converter circuit.
3. Develop the skills related to control circuit of power electronics converters.

Course Outcomes

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

CO1. Design and implement the power and control circuit of dc-dc converters
CO2. Design and implement the power and control circuit of ac-dc and dc-ac converters
CO3. Generate PWM signals for switches in power electronics converter using microcontroller/DSP.
CO4. Design PCB for power electronics converters.

Course contents:

This lab includes the design, development and testing of experimental prototypes of following experiments. The students can form a group of two or three and develop at least six prototypes from the following list.

1. Development of 48 V uncontrolled AC-DC converter using auto transformer.
2. Development of SCR based full wave converter.
3. Development of control circuit for SCR based full wave converter using either Arduino or microcontroller to generate triggering pulses.
4. Development of single phase/three phase bridge inverter using MOSFET.
5. Control circuit for single/three phase bridge inverter (MOSFET) with sinusoidal PWM. Use preferably Arduino/microcontroller to generate triggering pulses.
6. Development of single/three phase bridge inverter using IGBT.
7. Control circuit for Single/Three phase bridge inverter (IGBT) with single pulse/multi pulse/sinusoidal modulation Use preferably Arduino/microcontroller to generate triggering pulses.
8. Development of MOSFET based DC-DC buck converter.
9. Development of MOSFET based DC-DC boost converter.
10. Control circuit for MOSFET based DC-DC buck converter. Use preferably Arduino/microcontroller to generate triggering pulses.
11. Control circuit for MOSFET based DC-DC boost converter. Use preferably Arduino/microcontroller to generate triggering pulses.
12. Design and development of PCB using suitable software.

Term work:

The term work shall consist of submitting a report based on the selected experimental prototype. The course teacher will assess the term work.

Practical Examination:

The Practical Examination shall comprise the presentation (PPT) and experimental performance of the selected experimental prototype.

Internal examiner and external examiner will assess the end sem. examination.

EE52005: Advanced Control System			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Test	: 20 Marks
Tutorial	: 0 Hrs/Week	Teachers Assessment	: 20 Marks
Credits	: 03	End Semester Exam	: 60 Marks

Course Description:

This course is one semester mandatory course of four credits. This course introduces the basics of various control system which will be helpful for understanding the power system applications.

Course Objectives:

The objectives of the course are to-

1. Explain the system representation in state space and design of state feedback
2. Explain the basics for design of robust control system
3. Explain the stability analysis of non linear control systems
4. Explain the representation of optimal control systems
5. Explain the applications industrial controllers
6. Explain the multiloop control systems

Course Outcomes:

After completing the course, students will able to:

CO1	Represents system in state space and design state feedback
CO2	Design robust control system
CO3	Check the stability of non linear control systems
CO4	Represents the system in standard form of optimal control
CO5	Apply industrial control for system and realize multi loop control system

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 10 Marks
2. MCQ 10 Marks

Approved in XIX[th] Academic Council, dated 27/07/2018

EE52006 : ADVANCED ELECTRIC DRIVES			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0	Teachers' Assessment	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Course Description: The objective of this course is to give exposure to the students of fundamentals, operations, control and analysis of DC motor and AC motor electrical drives. It also covers the industrial application of it.

Prerequisites: 1. Electrical Machines
2. Power Electronics

Course Objective:

The objective of this course is to give exposure to the students of

1. Fundamentals of an electrical drives
2. Basics, Control and analysis of DC motor drives
3. Basics, Control and analysis of Induction motor drives
4. Vector control of Induction motor drives
5. Basics, Control and analysis of PM Synchronous and Brushless DC motor drives

Course Outcomes

After completing the course, students will able to:

CO1	Describe fundamentals of an electrical drives
CO2	Explain the operations and analysis of Phase controlled and Chopper controlled DC Motor drives
CO3	Explain the operations and analysis of Phase controlled and Frequency Controlled Induction Motor Drives
CO4	Discuss the principle and analysis of Vector controlled Induction Motor Drives
CO5	Discuss the principle of operation, analysis of P.M. Synchronous and Brushless DC Motor Drives

Detailed Syllabus:

Unit 1	**Phase Controlled and Chopper Controlled DC Motor Drives:** Phase Controlled- Introduction, Principle of DC motor speed control, Phase controlled converters, Steady state analysis of three phase converter controlled DC Motor drives, Applications. Chopper Controlled- Introduction, Principle of the chopper, Four quadrant Chopper circuit, Chopper for inversion, Steady state analysis of chopper controlled DC motor drives, Applications.
Unit 2	**Voltage Fed and Current Fed Converters:** 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. Current Fed Converters- Introduction, General operation of six stepped thyristor inverter, Load commutated inverters, 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 drives, Static Scherbius drive, modified static Scherbius 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 drive.

Unit 5	**Control and Estimation of Synchronous Motor Drives:** Introduction, Sinusoidal SPM machine drives, Synchronous reluctance machine drive, sinusoidal IPM machine drive, trapezoidal SPM machine drive, Wound Field synchronous machine drive, switched reluctance motor drives.

TEXT BOOKS:

1. B. K. Bose, "Modern Power Electronics and AC drives", Pearson Education, Asia, 2003
2. R. Krishan, "Electric Motor Drives- Modelling Analysis and Control", Pearson Prentice Hall.
3. G.K. Dubey, "Fundamentals of Electrical Drives", Narosa Publication
4. N.K. De and P.K.Sen "Electric Drives", Prentice Hall India
5. B.K. Bose, "Power Electronics and Variable Frequency Drive", IEEE Press, 2000
6. VedamSubramanyam, "Electric Drives Concepts and Applications", Tata McGraw-Hill

Teacher Assessments:

Assessments will be based on any one or two of the following:

1. Assignment 10/20 Marks
2. MCQ 10/20 Marks
3. PPT 10/20 Marks
4. Surprise Test 10/20 Marks

EE52007 : SIMULATION LABORATORY II			
Teaching Scheme		**Examination Scheme**	
Practical	: 04 Hrs/Week	Term Work	: 25 Marks
Credits	: 02	Viva-voce	: 25 Marks
		Total	: 50 Marks

Term Work Shall consist of record of minimum eight experiment/assignment using engineering computation software such as MATLAB, PSCAD, ETAP with moderate to high complexity

EE52008: LAB ELECTRIC DRIVES			
Teaching Scheme		**Examination Scheme**	
Practical	: 4 Hrs/Week	Term Work	: 25Marks
Total Credits	: 2	Practical Exam/Oral	: 25 Marks

Course Objectives

The objectives of the course are to-

1. To expose the students to a variety of electric drives.
2. To provide hand-on experience in ac and dc drives.

Course Outcomes

After completion of this course students will be able to

CO1. Write a code for the selected DSP/microcontroller to controls the dc motor drives.
CO2. Write a code for the selected DSP/microcontroller to controls the ac motor drives.
CO3. Develop technical writing skills important for effective communication
CO4. Acquire teamwork skills for working effectively in groups

List of the Experiments

1. Three experiments based on study and / or simulation of voltage fed , current fed converters and electric drives (mentioned in the syllabus) using MATLAB/SIMULINK/PSPICE
2. Three experiments based on study and / or experimentation on following electrical drives
   a. DC motor drive
   b. V/F induction motor control drive
   c. Vector control of induction motor drive
   d. Synchronous motor drive
   e. Special machines The student shall perform minimum eight experiments of the following:

Term work:

The term work shall consist of submitting a file for minimum six experiments performed with neatly written records of the study, circuit diagrams, observations, and graphs with results.
The term work will be assessed by the course coordinator

Practical Examination:

The Practical Examination shall comprise of performing the experiment and viva voce on the syllabus
The practical will be assessed by two examiners, one will be internal examiner and other will be external examiner appointed by DSB

EE52009 : MINI PROJECT WITH SEMINAR			
Teaching Scheme		**Examination Scheme**	
Practical	: 04 Hrs/Week	Term Work	: 25 Marks
Credits	: 02	Viva-voce	: 25 Marks
		Total	: 50 Marks

Prerequisite: Not applicable

Course Description: The student shall collect, review, compile, comprehend, present research literature and identify the problem for the dissertation in the field of Electrical Power System. Student will present seminar on work done by them on any topic of the recent technology. The seminar may include some simulation carried out by the student.

Course Objectives

- To understand the "Product Development Process" including budgeting through Mini Project
- To plan for various activities of the project and distribute the work amongst team members
- To inculcate electronic hardware implementation skills
- To develop student's abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project
- To understand the importance of document design by compiling Technical Report on the Mini Project work carried out

Course Outcomes

At the end of course students will be able to -

- Understand, plan and execute a Mini Project
- Implement electronic hardware by learning PCB artwork design, soldering techniques, testing, and troubleshooting etc.
- Prepare a technical report based on the Mini project
- Deliver technical seminar based on the Mini Project work carried out

Course Contents

- Mini Project Work should be carried out in the Laboratory.
- Data sheets may be referred, well known project designs ideas can be necessarily adapted from recent issues of electronic design magazines
- Hardware/Software based projects can be designed

  Following areas are just a guideline

  - Instrumentation and Control Systems
  - Power Electronics
  - Embedded Systems/ Microcontroller based projects should preferably use Microchip PIC controllers/ATmega controller/AVR microcontrollers
  - Power system based

- Demonstration and Group presentations. Logbook for all these activities shall be maintained and shall be produced at the time of examination
- A project report with following contents shall be prepared:

  - Specifications/Block diagram/Circuit diagram/Selection of components, calculations
  - Simulation results
  - Layout versus schematic verification report
  - Testing procedures/Test results Conclusion
  - References

Term Work:

The Mini Project with Seminar shall consist of collection of literature from a chosen field of Electrical Engineering from various sources such as refereed journals, proceedings of national international conferences, PG/PhD theses etc. Based on the literature survey, case studies, data collection, surveys, pilot studies, mathematical/analytical modeling, etc., as necessary the candidate shall define the problem for the dissertation.

The candidate shall prepare a technical report in a prescribed format and present before a panel of examiners consisting of guide and at least one faculty member of the department.

Viva Voce Examination: It consists of two parts.

Part-I: Mid-Term Evaluation for 10 Marks: A mid-term evaluations for 10 marks out of 25 marks shall be done as per the schedule given in the institute academic calendar. Student should prepare a power point presentation and present before the panel of examiners and class students and should be able to answer questions asked by the panel of examiners and class students. Panel of examiner consists of guide as internal examiner and one faculty members appointed by the DCoE as external examiners. The panel of examiner will assess the contents and presentation and give the suggestions, if any and assigns the marks out of 10. In this phase student is expected to collect and present substantial literature.

Part-II: End Semester Evaluation for 15 Marks: Student should prepare technical report in prescribed format duly incorporating suggestions of Part-I and present power point presentation before the panel of examiners and class students. The student should be able to answer the questions asked. The panel of examiner will assess the seminar contents and seminar presentation and assigns the marks out of 15. In this phase the students is expected to define the problem for dissertation through further literature survey, case studies, data collection, surveys, pilot studies, mathematical/analytical modeling, etc., as necessary.

Approved in XIX th Academic Council, dated 27/07/2018

Syllabus of Electives I, II, III, IV and V

EE52010 : FUZZY LOGIC AND ARTIFICIAL NEURAL NETWORKS (Program Elective I)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0 Hrs/Week	Teachers' Assessment	: 20 Marks
Total Credits	: 3	End -Semester Exam	: 60 Marks

Course Description: - This course introduces students to the fundamental knowledge, theories and applications of fuzzy logic and neural networks. It gives the knowledge of principles of fuzzy sets and fuzzy logic, fuzzy inference and control. It also gives students an understanding of the structures and learning process of a neural network. Topics covered are: fuzzy set theory, fuzzy arithmetic and fuzzy logic operations, fuzzy functions and fuzzy relations, fuzzy logic control, basic concepts of neural networks, single-layer and multilayer Perceptrons (MLP), self-organizing maps and neural network training.

Course Objectives: -The objectives of the course are to

1. Introduce to basic concept of artificial neural network
2. Introduce to various neural network models and their learning and training
3. Introduce to basic concept of artificial neural network
4. Introduce to design of fuzzy logic system
5. Explain applications of fuzzy logic system and neural network

Unit wise Course Outcomes expected:

Students will be able to

CO1. Construct simple neural network
CO2. Compare various models of neural network
CO3. Develop fuzzy logic system
CO4. Apply fuzzy logic system to any application
CO5. Apply neural network system to any application

Detailed Syllabus:

UNIT-I	**Artificial neural network:** Introduction, Neuron Physiology, Artificial Neurons, and Artificial Neural Networks supervised Learning, Early Learning Models, and Features of Artificial Neural Networks.
UNIT-II	**Neural Network Model:** Vector and Matrix Notation, Neural network model,architecture, Back propagation, Recurrent Neural Network, Elman Back propagation Neural Network.
UNIT-III	**Fuzzy Logic Systems:** Introduction, Foundation of Fuzzy Systems, Representing Fuzzy Elements, Basic Terms and Operations, Properties of Fuzzy Sets, Fuzzification, Arithmetic Operations of Fuzzy Numbers, The alpha cut method, The extension method , Linguistic Descriptions and their Analytical Forms, Fuzzy Linguistic Descriptions, Fuzzy Relation Inferences, Fuzzy Implication and Algorithms, Defuzzification Methods, Centre of Area Defuzzification, Centre of Sums Defuzzification
UNIT-IV	**Application of neural network :**Application of neural network to various system at least three such as power system etc.
UNIT-V	**Application of fuzzy logic to power system:** Application of fuzzy logic to various system at least three such as power system etc.

Text Books:

1. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", OXFORD University Press, New Delhi, 2005
2. Stamations V. Kartalopoulos, "Understanding Neural Networks and Fuzzy Logic: Basic concepts and Applications", PHI, New Delhi, 2002.
3. Kevin Warwick, Arthur Ekwue and Raj Aggarwal, "Artificial Intelligence Techniques in Power Systems", IEE Power Engineering Series, UK, 1997.
4. Springer Berlin Heidelberg, "Intelligent Systems and Signal Processing in Power Engineering", New York

1. Teaching Strategies:

The teaching strategy is planed through the lectures, tutorials and team based home works. Exercises are assigned to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

2. Teacher's Assessment: Teachers Assessment of 20 marks is based on one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Approved in XIX[th] Academic Council, dated 27/07/2018

EE51012: ILLUMINATION ENGINEERING (Program Elective I)				
Teaching Scheme		**Examination Scheme**	
Lectures	**: 03 Hrs/Week**	**Test**	**: 20 Marks**
Tutorial	**: 0 Hrs/Week**	**Teachers Assessment**	**: 20 Marks**
Credits	**: 03**	**End Semester Exam**	**: 60 Marks**

Course Description:

Illumination Engineering is one semester course. The students can opt this course as professional elective. It is the fundamental course related to power system engineering.

Course Objective:

The objectives of the course are to

1. To explain how light bulbs can transfer energy and the concepts behind different light bulb technologies, and to use ideas about reflection to design a flood light reflector.
2. To evaluate the impact of different technologies on society and different technological approaches to a challenge.
3. To conduct cost benefit analysis and evaluate different solutions using set criteria.
4. Students will be able to compare the relative proportions of light and heat released by different types of bulbs.
5. To design lighting scheme for indoor and outdoor

Course Outcomes:

After completing the course, students will be able to:

CO1	Identify the criteria for the selection of lamps and lighting systems for an indoor or outdoor space;
CO2	Carry out field survey for the lighting conditions of a project site; .
CO3	Perform calculations on photometric performance of light sources and luminaries for lighting design;
CO4	Examine daylight in buildings and its effect on lighting design; Evaluate different types of lighting designs and applications, Design indoor and outdoor lighting systems.
CO5	Enlist state of the art illumination systems.

Detailed Syllabus:

Unit 1	**Lighting in Human Life:** Radiation, color, eye & vision; different entities of illuminating systems; Light sources: daylight, incandescent, electric discharge, fluorescent, arc lamps and lasers; Luminaries , time luminance, Good and bad effects of lighting & perfect level of illumination, physics of generation of light, Properties of light, Quantification & Measurement of Light, lighting for displays and signaling- neon signs, LED-LCD displays beacons and lighting for surveillance.
Unit 2	**Electrical Control of Light Sources:** Environment and glare., lighting for displays and signaling- neon signs, LED-LCD displays beacons and lighting for surveillance Types of Luminaries, factors to be considered for designing luminaries Types of lighting fixtures. 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 lightingfixtures according to installation type, types of lighting fixtures according to photometric usages, luminaries standard (IEC-598-Part I).
Unit 3	**Light Sources:** Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. design considerations and characteristics of Discharge Lamps low and high mercury

	and Sodium vapour lamps, Fluorescent Lamp, Compact Fluorescent Lamp (CFL) High Vapour Pressure discharge lamps - Mercury Vapour lamp, Sodium Vapour lamp, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps.
Unit 4	**Illumination scheme** Factors to be considered for design of indoor illumination scheme Indoor illumination design for following installations Residential lighting scheme , Hospitals Industrial lighting ,Special purpose lighting schemes Theatre lighting ,swimming pool lighting
Unit 5	**Design of lighting scheme** Factors to be considered for design of outdoor illumination scheme, Outdoor Lighting Design: Road classifications according to BIS, pole arrangement, terminology, lamp and luminaries selection, point by point method, problems on point by point method. Outdoor illumination design for following installations Road lighting Flood lighting ,LED luminary designs ,Intelligent LED fixtures

Text and Reference Books:

1. H. S. Mamak, "Book on Lighting", Publisher International lighting Academy
2. Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to Lasers" Publisher - York, PA : Visions Communications
3. M. A. Cayless, A. M. Marsden, "Lamps and Lighting", Publisher-Butterworth-Heinemann(ISBN 978-0-415-50308-2)
4. Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002
5. "BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", Manak Bhavan, New Delhi
6.. D. C. Pritchard, "Lighting", 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422-

Teacher's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Teaching Strategies:

The teaching strategy planned through the lectures, and team based home works. Exercises assigned weekly to stimulate the students to actively use and revise the learned concepts, which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes emphasized

Special Instructions if any: Nil

Approved in XIX th Academic Council, dated 27/07/2018

EE 52011: SPECIAL MACHINES (Program Elective I)			
Teaching Scheme:		**Examination Scheme:**	
Lectures	: 03 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0 Hr/ Week	Teachers Assessment	: 20 Marks
Total Credits	: 3	End Semester Exam	: 60 Marks

Course Description:
The objective of this course is to give exposure to the students of various special electrical machines, their operation, control and industrial applications. It also covers performance characteristics, and mathematical analysis of it.

Prerequisites: 1. DC and AC Electrical Machines
2. Engineering Mathematics

Course Objectives:
The objective of the course is to give exposure to the students of
1. Principle of operation, analysis and applications of Servo motors
2. Principle of operation, analysis and applications of Stepper motors
3. Basics, analysis and applications of Switched reluctance motor
4. Performance analysis and use of Brushless DC motor
5. Performance analysis and applications of linear induction motor

Course Outcomes:
After completing the course, students will able to:

CO1	Explain the operations , analyze the performance of servo motors and identify applications
CO2	Explain the operations, analyze the performance of stepper motor and identify applications
CO3	Describe the operations , analyze the performance of Switched reluctance motor and identify applications
CO4	Analyze and identify the applications of BLDC motor
CO5	Analyze and use LIM for industrial applications

Detailed Syllabus:

Unit 1	**Servo motors:** Introduction, types, principle of operation, construction, characteristics, controllers, applications
Unit 2	**Stepper motors:** Introduction, hybrid stepping motor, different configurations for switching control circuits, Variable reluctance stepping motor, characteristics, areas of applications, 5-phase hybrid stepping motor, 1-phase stepping motor, mathematical analysis of stepping motor
Unit 3	**Switched reluctance motor:** Introduction, principle of operation, design aspects, power converters for SR motors, rotor sensing mechanism and logic controller, torque expression, torque calculations, torque-speed characteristics, applications
Unit 4	**Brushless DC motor:** Construction, principle of operation, sensing and switching logic schemes, drive and power circuits, theoretical and transient analysis, control strategies, applications

Unit 5	**Linear induction motor:** Double sided LIM, LIM drive, one side LIM, field analysis, 1-D analysis, transverse edge effects in LIM, solutions for current distribution, applications

Text & Reference Books:

1. Toro V.D, "Electric machines and power systems", Prentice Hall of India, 1985
2. Veinott, "Fractional horse power electric motors", McGraw Hill, 1948
3. K. Venkatraman, " Special Electrical Machines" Orient Black swan/ Universities press , 2008
4. A. E. Fitzergerald, C.Kingsly, S.D.Umas, "Electric Machinery", TMH

Teacher's Assessment:

The teacher's assessment should be done based on any one or combination of any two of the following scheme.

1. Assignments : 10/20 Marks
2. Objective type test : 10/20 Marks
3. Modelling of electrical machines using any electrical software : 10/20 Marks
4. Technical/Industrial visit report / Quiz : 10/20 Marks

Approved in XIX th Academic Council, dated 27/07/2018

EE 52012: INDUSTRIAL AUTOMATION AND CONTROL (Program Elective I)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0 Hr/Week	Teachers' Assessment	: 20 Marks
Total Credits	: 3	End -Semester Exam	: 60 Marks

Pre-requisites: Control systems

Course Description: - Provides the student with basic knowledge of the industrial automation. This course introduces the basic concept of process control, building blocks of automation, various control configurations.

Course Objectives: -The objectives of the course are to

1. Describe various measurement systems using sensors
2. Explain various process control configuration
3. Illustrate various controllers used in industry
4. Explain PLC, SCADA, PDC systems
5. Describe and Illustrate valves used in Industry

Unit wise Course Outcomes expected:

Students will be able to

CO1. Use various sensors for measurement of physical parameters
CO2. Analyze various control configurations used in process control
CO3. Use controller such as P, PI, PID
CO4. Design systems using PLC, SCADA, DDC configuration as control values for application
CO5.Compare various control valves

Detail syllabus

UNIT-I	**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-II	**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-III	**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-IV	**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-V	**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 Systems : 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.

TEXT BOOKS:

1. Dobrivojie Popovic, Vijay P.Bhatkar, "Distributed Computer Control for Industrial Automation", Dekker Publications.
2. Webb and Reis," Programmable Logic Controllers: Principles and Applications", PHI.
3. S.K. Singh, "Computer Aided Process Control", PHI
4. Garry Dunning, "Introduction to Programmable Logic Controllers", Thomson Learning.
5. N. E. Battikha, "The Management of Control System: Justification and Technical Auditing", ISA
6. Krishna Kant, "Computer Based Process Control", PHI
7. Fu, Lee, Gonzalez, "Robotic Control, sensing and Intelligence", Tata McGraw-Hill

1. Teaching Strategies:

The teaching strategy is planed through the lectures, tutorials and team based home works. Exercises are assigned to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

2. Teacher's Assessment: The teacher's assessment should be done based on any one or combination of any two of the following scheme.

1. Assignments	: 10/20 Marks
2. Objective type test	: 10/20 Marks
3. Modelling of electrical machines using any electrical software	: 10/20 Marks
4. Technical/Industrial visit report / Quiz	: 10/20 Marks

EE 52013 : RELIABILITY AND CONDITIONING MONITORING (Program Elective I)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Class Test	: 20Marks
Tutorial	: 0	Teachers' Assessment	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Course Objective:

The objectives of the course are to

1. Know engineering system monitoring and fault diagnosis and explains the basic concepts of condition monitoring.
2. Know how modern technology, quality control and environmental issues have affected current thinking.
3. Protect themselves and others in the workplace and focuses on the safety measures needed when Carrying out monitoring activities, especially those for isolating equipment.
4. Know how to use a range of condition monitoring equipment and will develop the skills and knowledge required for the location and identification of faults in engineering systems.
5. Learners will be required to select the appropriate monitoring technique and equipment based on the type of plant or equipment being monitored and the conditions checked.

Course Outcomes:

After completing the course, students will be able to:

CO1	Know the health and safety requirements relevant to monitoring and fault diagnosis of engineering Systems.
CO2	Know about system monitoring and reliability.
CO3	Use monitoring and test equipment
CO4	Carry out fault diagnosis on electrical engineering equipment
CO5	Develop model for improvement in life of electrical equipment.

Detailed Syllabus:

Unit 1	**Introduction to the field of machine condition monitoring:** methods, tools used to monitor a machine, diagnostics and prognostics, reliability, maintenance practices, health usage monitoring, Frequency of monitoring, infrared thermography, Ultrasounds
Unit 2	**Failure analysis:** Failure mode-effect and criticality analysis, fault tree analysis. Breakdown mechanisms in gases, liquids, vacuum, solids. maintenance strategies (breakdown, preventive, planned, scheduled, diagnostic, total productive maintenance, reliability centered maintenance) organization for maintenance, maintenance requirements, maintenance planning and work control, maintenance records, frequency of maintenance, cost of maintenance, maintenance effectiveness
Unit 3	**Condition Monitoring of Transformer:** Type of faults, duration and the impacts Interpretation of gases generated in Oil-Immersed Transformer, Transformer winding and core deformation detection utilizing SFRA technique, Methods of Dissolved Gas Analysis (DGA), partial discharge
Unit 4	**Diagnosis of electrical equipment:** Motors, generators, Configuration, problems, diagnosis and solutions, Causes of motor failure, remedies. Signature analysis, condition monitoring of induction motor, power cables
Unit 5	**Substation Maintenance:** Types – Routine, Preventive, Planned, Predictive, Break-down, Emergency maintenance, on-line maintenance of different equipments, Condition monitoring of power apparatus, New advanced techniques in diagnosis and monitoring of electrical equipment.

Text and Reference Books

1. Advances in high voltage engineering, edited by A. Haddad and D. Warne, IEE Power and EnergySeries, 2004.
2. Electrical Insulation in Power Systems, N. H. Malik, A. A. Al-Arainy and M. I. Qureshi, Marcel Dekker,1997.
3. Insulation of High Voltage Equipment, V.Y. Ushakov, Springer-Verlag, 2004.
4. High Voltage Engineering Fundamentals, KuffelZaengelKuffel, Newnes
5. K. B. Raina, S. K. Bhattacharya, Electrical Design, Estimation and costing, wiely eastern limited NewDelhi 1991.
6. S. L. Uppal- Electrical Power- Khanna Publishers Delhi.
7. Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence, W.H. Tang, Q.H. Wu ,ISBN: 978-0-85729-051-9
8. Handbook of Condition Monitoring: Techniques and Methodology Edited by A. Davies
9. Advances in Electrical Engineering and Electrical Machines Editors: DehuaiZheng, ISBN: 978-3- 642-25904-3

Teacher's Assessment: Teachers Assessment of 20 marks is based on attendance of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Approved in XIX[th] Academic Council, dated 27/07/2018

Program Elective II

EE 52014: MICROCONTROLLERS & ITS APPLICATIONS (Program Elective II)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Test	: 20 Marks
Tutorial	: 00 Hrs/Week	Teachers Assessment	: 20 Marks
Credits	: 03	End Semester Exam	: 60 Marks

Course Description: The purpose of this course is to teach students the fundamentals of microprocessor and microcontroller systems. The student will be able to incorporate these concepts into their electronic designs for other courses where control can be achieved via a microprocessor/controller implementation.

Prerequisites:

Digital Electronics

Course Objectives:

The objectives of the course are to

1. Explain the architecture of microprocessor 8086 and micro controller 8051.
2. Explain the assembly language program for microprocessor 8086.
3. Explain the assembly language program for micro controller 8051.
4. Explain the interfacing of peripheral with microprocessor 8086.
5. Explain the interfacing of peripheral with micro controller 8051.

Course Outcomes:

After completing the course, students will able to:

CO1	Describe the architecture of microprocessor 8086 and micro controller 8051 and its peripheral devices.
CO2	Interface input output devices to micro processor 8086.
CO3	Write assembly language program in 8086 for various applications.
CO4	Write assembly language program in microcontroller 8051 for various application.
CO5	Interface the input output devices to micro controller 8051.

Detailed Syllabus:

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.

Text Books:

1. B Ram, "Fundamentals of Microprocessors and Microcomputers", DhanpatRai and Sons, New Delhi, ivthEdition.
2. R.A.Gaonkar, "Microprocessor Architecture Programming and Applications with 8085",Penram
3. Badri Ram, "Advanced Microprocessor and interfacing", Tata McGraw Hill, New Delhi.

Reference Books:

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

Teacher's Assessment:

Teachers Assessment of 20 marks is based on one of the / or combination of few of following,

1. Mini projects.
2. PPT presentation.
3. Assignment based on programming of microcontroller for different applications.

Approved in XIX[th] Academic Council, dated 27/07/2018

EE 51015 : WIND ENERGY SYSTEMS (Program Elective II)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Class Test	: 20Marks
Tutorial	: 0	Teachers' Assessment	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Pre-requisites: Engineering Physics, Electrical Machines, Power Systems

Course Description:
In this curriculum, students will be explored to Wind Energy Technologies

Course objectives:
The objectives of the course are to

1. Calculate and analyze wind resource and energy production for a wind turbine from wind speed distribution, wind shear and power curve
2. Describe Weibull and Rayleigh statistics
3. Understand different types of generators in association with wind turbines
4. Describe different control methods for wind turbines
5. Grid integration of wind energy systems and its associated issues

Course outcomes:

After completing the course, students will able to

CO1.	Analyze wind resources and energy production from wind turbines
CO2	Calculate annual energy using Weibull and Rayleigh statistics
CO3	Select different generators for a particular wind turbine
CO4	Discuss wind energy technologies and explain its control
CO5	Explain grid integration of wind energy systems and its associated issues

UNIT-I	**Basics of Wind Energy:** Historical development of wind turbines, wind energy fundamentals, wind turbine aerodynamics, wind speeds and scales, terrain, roughness, power content, atmospheric boundary layer turbulence, Wind measurements, devices for measurements, analysis and energy estimates, Betz's limit.
UNIT-II	**Wind Power Probability:** Discrete wind histograms, Wind power Probability density function, Weibull and Rayleigh statistics, Average power in the wind, estimates of wind turbine energy, annual energy calculations, Wake effect in wind farms, capacity factor, impact of tower height
UNIT-III	**Wind Turbine Generators:** Synchronous generator, Induction generator, speed control for maximum power, importance of variable rotor speeds, pole changing induction generators, variable slip induction generators, idealized wind turbine power curve
UNIT-IV	**Wind Energy Technology:** Tip speed ratio, stall and pitch control, wind generator topologies, voltage and reactive power control, power quality standard for wind turbines
UNIT-V	**Grid Integration of Wind Energy:** Wind farms, real and reactive power regulation, voltage and frequency operating limits, wind farm behavior during grid disturbances, grid synchronization system, Economic aspects

Text and Reference Books:

1. Thomas Ackermann, Editor, "Wind Power in Power Systems", John Willy and sons ltd., 2005,ISBN 0-470-85508-8.

2. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", John Willy and sons,2004,ISBN0-471-28060-7.

3. Siegfried Heier, "Grid integration of wind energy conversion systems" John Willy and sons ltd.2006.

4. Fresis L. L., Wind Energy Conversion Systems, Prentice Hall, 1990.

5. D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.

6. Mathew Sathyajith, Geetha Susan Philip, Advances in Wind Energy Conversion Technology, Springer, 2011

Teacher's Assessment: Teacher's Assessment is based on one of the following.

1) Assignments
2) Models/ Presentations
3) multiple choice questions test
4) Quiz

EE 52015: ELECTRICAL MACHINE DESIGN (Program Elective II)			
Teaching Scheme:		**Examination Scheme:**	
Lectures	: 03 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0	Teachers Assessment	: 20 Marks
Total Credits	: 03	End Semester Exam	: 60 Marks

Course Description:

To develop knowledge on principles of design of static and rotating machines. Also students must able to understand the design fundamental concepts, design main dimensions & cooling systems of transformers and main dimensions of rotating machine.

Prerequisites: 1. DC and AC Electrical Machines
2. Engineering Mathematics

Course Objectives:

The objective of the course is to give exposure to the students

1. Learn basic considerations required design of static and rotating machines.
2. Understand design parameters for D.C. machines.
3. Learn design of different parts of transformers
4. Study various parameters of Induction and synchronous machine

Course Outcomes:

After completing the course, students will able to:

CO1	Describe basic considerations required for electrical machine design
CO2	Evaluate design parameters D.C. machines.
CO3	Explain design of different parts of transformers
CO4	Explain design parameters of Induction motor
CO5	Evaluate design stator and rotor parameters of synchronous machines

Detailed Syllabus:

Unit 1	**Principles of Electrical Machine Design:** Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines.
Unit 2	**Design of DC Machines:** Output equation, choice of specific loadings and choice of number of poles, design of Main dimensions of the DC machines, Design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and poles-main and inter poles, field windings – shunt, series and inter poles.
Unit 3	**Design of Transformers:** Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and conductor cross sectional area of Primary and secondary windings, estimation of no load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes
Unit 4	**Design of Induction Motors:** Output equation, Choice of specific loadings, main dimensions of three phase induction motor, Stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of Rotor bars and end ring, design of Slip ring induction motor
Unit 5	**Design of Synchronous Machine:** Output equation, Choice of specific loadings, short circuit ratio, design of main dimensions, armature slots and windings, slot details for the stator of salient and non salient pole synchronous machines. Design of rotor of salient pole synchronous

	machines, magnetic circuits, dimensions of the pole body, design of the field winding, and design of rotor of non-salient pole machine

Text Books:

1. Sawhney A.K., Chakrabarti A., "A Course in Electrical Machine Design", DhanpatRai& Sons Company Limited, New Delhi, 6th Edition, 2006.
2. Mittle V.N., Mittle A., "Design of Electrical Machines", Standard Publications and Distributors, New Delhi, 2002.

Reference Books:

1. Sen, S.K, "Principles of Electric Machine Design with Computer Programmes", Oxford & IBH Publishing Company Private Limited, 2001, Reprint 2004.
2. Agarwal R.K., "Principles of Electrical Machine Design", S.K.Kataria and Sons, New Delhi, 2002.
3. Shanmugasundaram, A., Gangadharan G. and Palani R., "Electrical Machine Design Data Book", New Age International Publishers Private Limited., 1st Edition 1979, Reprint 2005

Teacher's Assessment:

The teacher's assessment should be done based on any of following scheme.

1. Assignments
2. Objective type test
3. Design electrical machines using any electrical software
4. Quiz
5. Presentation on advanced topic related to any type of machine design

EE 52016: DIGITAL CONTROL SYSTEM (Program Elective II)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03Hrs/Week	Class Test	:20Marks
Tutorial	: 0	Teachers Assessment	: 20 Marks
Total Credits	: 4	End -Semester Exam	: 60 Marks

Pre- Requisite: Advance Control System

Course description: The purpose of this course is to teach students the fundamentals of Digital Control Systems.

Course objectives: -The objectives of the course are to

1. Explain sampling and reconstruction
2. Illustrate transform analysis of sampled data system
3. Explain the design of digital controls
4. Describe self-tuning
5. Illustrate the control applications of microprocessor based control system

Unit wise Course Outcomes expected:

After completion of this course students will be able to

CO1: Model the System In Discrete Form
CO2. Analyze the stability of system in discrete form
CO3. Design sample data control system using frequency domain techniques
CO4. Design sample data control system using time domain techniques
CO5. Represent system in state space form

Detail syllabus

UNIT-I	Sampling and Reconstruction: Sampled data control system, Digital to Analog conversion, Analog to Digital conversion, Sample and Hold operation
UNIT-II	Transform analysis of Sampled Data systems: Linear difference equation, The pulse response, The Z-transform, The pulse transform, Block diagram analysis of sampled data systems, Z-domain equivalents to S-domain compensator, Stability analysis, Systems with dead time
UNIT-III	Transform design of Digital Controls: Design specification, Design on ω plane, Design on z plane, Digital PID controller, Discrete time state equations similarity transformation
UNIT-IV	Self-tuning control: Identification problem, principle of least squares, self-tuning regulators
UNIT-V	Case studies, Temperature control system, Stepping motors

Text Books:
Digital Control Engineering, M. Gopal, New Age International Publications, Second Edition

Teaching Strategies:
The teaching strategy is planed through the lectures, tutorials and team based home works. Exercises are assigned to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

Teacher's Assessment: Teacher's Assessment based on one of the /or combination of the few of the following.

1) Assignment
2) Multiple choice question

EE 51014 : SMART GRID TECHNOLOGY (Program Elective II)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs/Week	Test	: 20 Marks
Tutorial	: 0 Hrs/Week	Teachers Assessment	: 20 Marks
Credits	: 03	End-Semester Examination	: 60 Marks

Course Description: This course introduces the concepts of smart grid technology & covers the various aspects of smart grid.

Course Objectives:

The objectives of the course are to:

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
1. Understand concept of power quality issues in Smart grid
2. Appreciate problems associated with integration of distributed generation & its solution through smart grid

Course Outcomes

After completing the course, students will able to:

CO1	Differentiate between smart grid & conventional grid
CO2	Explain smart grid technologies
CO3	Explain the concept of micro grid & issues of micro grid interconnection
CO4	Identify the power quality issues in Smart grid
CO5	Explain different Communication Technology for Smart Grid

Detailed Syllabus:

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 mioro 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.

Text and Reference 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, Kithsiri Liyanage, 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's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following.

1. Presentation on latest topics/Real life problems related with the subject
2. Simulations problems
3. Quiz
4. MCQ

Program Elective III

EE51021 : POWER QUALITY (Program Elective III)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 00	Teachers' Assessment	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Pre-requisites: Power Electronics, Electrical Machines, Power System

Course Description:

EE52005: This course gives an introduction on power quality causes and effects, requirement of power quality improvements and mitigation aspects of power quality problem .

Course objectives:

The objectives of the course are to

1. Understand power quality problem and classify power quality events
2. Understand different methods of monitoring power quality and standards for power quality
3. Outline concept of Passive shunt and series compensators
4. Understand Active Shunt and Series Compensators
5. Understand Unified Power Quality Compensators

Course Outcomes:

After completing the course, students will able to

CO1.	Describe Power quality problems and classify power quality events.
CO2	Demonstrate power quality measurement methods
CO3	Explain principle of operation and control of Passive shunt and series compensators.
CO4	Design of Active Shunt And Series Compensators
CO5	Analyze Unified Power Quality Compensators

UNIT-I	**Power Quality an Introduction:** Introduction , Classification of Power quality problems, Causes of power quality problems, Loads that cause power quality problem, classification of nonlinear load, Effects of power quality problems on users, Classification of mitigation techniques for power quality problems
UNIT-II	**Power Quality Standards and Monitoring:** Power Quality Terminologies, Power Quality Definitions, Power Quality Standards, classification of passive power filter, principle of operation of passive power filter
UNIT-III	**Passive Shunt and Series Compensation:** Classification of Passive shunt and series compensators, Principle of operation of Passive shunt and series compensators, Analysis and design of Passive shunt compensators
UNIT-IV	**Active Shunt And Series Compensation:** Classification of DSTATCOMs, principle of operation and control of DSTATCOM, analysis and designed of DSTATCOM, Classification of active series compensators, principle of operation and control of active series compensators, Analysis and designed of active series compensators
UNIT-V	**Unified Power Quality Compensators:** Classification of Unified power quality compensators, principle of operation and control of Unified power quality compensators, analysis and designed of Unified power quality compensators

Text Books:

1. BhimSingh, Ambrish Chandra (2015) "power quality problem and mitigation techinques" , wiley Publications (ISBN: 9781118922057)
2. C.Sankaran (2002)"power quality" CRC Press Publication.
3. Math, H. J. Bollen, "Understanding power quality problem", Standard Publication.
4. Roger C. Dugan, "Electrical power system quality"2nd edition, macgraw-Hill Publication.
5. Mohammed A. S. Masoum, Ewald F. Fuchs" Power Quality in power systems and electric machines",2nd Edition, kindely edition,(ISBN: 978-0123695369)

Teacher's Assessment: Teacher's Assessment is based on one of the /or combination of the few of the following.

1) Home Assignments
2) Power point presentation
3) Develop working models
4) Surprise written Test with multiple choice questions
5) Quiz

Approved in XIX th Academic Council, dated 27/07/2018

EE51018 : SOLAR ENERGY SYSTEMS (Program Elective III)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Class Test	: 20Marks
Tutorial	: 0 Hr/Week	Teachers' Assessment	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Pre-requisites: Engineering Physics, Electrical Machines, Power System

Course Description:

Solar Energy Systems This course will introduce the basics of solar Photovoltaic power generation and grid connection issues. This course will also describe thermal applications of solar power

Course Objectives:

The objectives of the course are to

1. Outline the technologies that are used to harness the power of solar energy
2. Design a stand-alone PV system
3. Understand the physics of solar PV systems and grid connected topologies
4. Understand different types of solar PV cells
5. Outline the different solar thermal technologies

Course Outcomes:

After completing the course, students will able to

CO1.	Determine I-V and P-V Characteristics of Solar cell
CO2	Design the various parameters of stand alone solar pv system
CO3	Understand different grid connected topologies based on isolation and power stages
CO4	Understand different types of solar pv cells
CO5	Understand different solar thermal collectors

UNIT-I	**Introduction to Solar Energy:** Solar Spectrum, Solar Geometry, Sun Earth angles, Solar radiation at given locations, Solar radiation measurement, sun path diagrams Light generated current, I-V & P-V Characteristics of silicon solar cell
UNIT-II	**Solar PV Technology:** Amorphous mono-crystalline, poly-crystalline, Shading impact, PV module, Array, Maximum Power Point Tracking, Standard test conditions, Impacts of temperature and Insolation on I-V curves Design of stand-alone systems
UNIT-III	**Solar PV Grid Integration:** Grid connection principle, Topologies for PV-Grid interface, Isolation, Number of power stages, Convertors based on control dynamics, d-q axis control methodology
UNIT-IV	**Thin film Technology:** Generic advantages of thin film technologies, Materials for thin film technologies, Cadmium Telluride solar cell, Introduction to Organic solar PV cell, Water pumping applications
UNIT-V	**Solar Thermal Technology:** Flat plate collector, Parabolic trough, Central receiver, parabolic dish, Fresnel, solar pond, solar still , Single node analysis of flat plate collectors, top loss and bottom loss coefficients

Text Books:

1. Chetan Singh Solanki, "Solar Photovoltaic Fundamentals, Technologies and applications", second edition, PHI Publication
2. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", John Willy and sons, 2004, ISBN0-471-28060-7.
3. S. P. Sukhatme and J.K.Nayak"Solar Energy principles of thermal collection and storage", Tata McGrew Hill, third edition,

4. A Elbaset Adel," Performance Analysis of Grid-Connected Photovoltaic Power Systems " Lambert Academic Publications

Reference Books:

1. Muhammad Sulaman, "Design & Analysis of Grid Connected Photovoltaic System" Lambert Academic Publications

2. Mullic and G.N.Tiwari, "Renewable Energy Applications", Pearson Publications.

3. John A. Duffie, William A. Beckman, "Solar Engineering of Thermal Processes", Wiley Inter science Publication, 1991.

Teacher's Assessment:

Teacher's Assessment is based on one of the /or combination of the few of the following.

1) Home Assignments
2) Power point presentation
3) Develop working models
4) Surprise written Test with multiple choice questions
5) Quiz

EE52017: ELECTRICAL DRIVES APPLICATIONS (Program Elective III)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Test	: 20 Marks
Tutorials	: 0 Hrs/Week	Teachers Assessment	: 20 Marks
Credits	: 03	End Semester Exam	: 60 Marks

Course Description:

Electrical Drives Applications is a one-semester course. The students can opt this course as a professional elective.

Course Objectives:

The objectives of the course are to:

1. Learn basic concepts of energy efficient motors
2. Know energy conservation issues in electrical drives
3. Learn electric drive systems for electric traction
4. Understand industrial applications of electrical drives

Course Outcomes:

After completing the course, students will be able to:

CO1	Understand basic concepts of energy efficient motors
CO2	Explain energy conservation issues in electrical drives
CO3	Explain electric drive systems for electric traction
CO4	Discuss industrial applications of electrical drives

Detailed Syllabus :

UNIT-1	**Energy Efficient Motors:** Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - variable speed, variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit.
UNIT-2	**Energy Conservation in Electrical Drives:** Losses in electrical drives system, measures for energy conservation in electrical drives, use of efficient semiconductor converters, use of variable speed drives, use of variable speed drives, Energy efficient operation of drives, improvement of power factor, improvement of supply quality, Single to three phase converters in rural applications, regular and preventive maintenance
UNIT-3	**Electric Traction:** General features of electrical traction, Mechanics of train movement, Nature of traction load, Speed-time curves, Calculations of traction drive rating and energy consumption, Train resistance, Adhesive weight and coefficient of adhesion, Tractive effort for acceleration and propulsion, Power and energy output from driving axles, Methods of speed control and braking of motors for traction load, Electric drive systems for electric traction. Electric cars and trolley buses, energy considerations. Electric and Hybrid Vehicles
UNIT-4	**Industrial Applications:** Various processes involved, Process/operation—Requirements of load—Suitable Drive selection, drives employed, their ratings and recent advancements in the drives for following applications Rolling/Steel mill, Paper mill, Cement mill, Textile mill, Sugar mill, Coal mining, Machine tool applications and Petrochemical industry

BOOKS:

1. Energy efficient electric motors by John C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995
2. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Pub House (2nd Edition)
3. Electric Traction by H. Partab, Dhanpat Rai & Sons.
4. Electric Drives by N. K. De & P. K. Sen, Prentice Hall of India Eastern Economy Edition
5. A first course on Electrical Drives by S. K. Pillai Wiley Eastern Ltd.

Teacher's Assessment:

Teachers Assessment of 20 marks is based on attendance of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related to the subject
2. Assignments
3. Quiz
4. Surprise test
5. MCQ

EE 51017: LIFE ESTIMATION OF POWER SYSTEM EQUIPMENT (Program Elective III)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0 Hr/Week	Teachers' Assessment	: 20 Marks
Total Credits	: 3	End -Semester Exam	: 60 Marks

Course Description: This course introduces the various aspects for estimating the residual life of power system equipments.

Course objectives: -The objectives of the course are to

1 Introduce to Dielectric behavior of electric field

2. Introduce to insulation failure

3. Introduce to diagnostic techniques

4. Introduce to reliability assessment

.Unit wise Course Outcomes expected:

Students will be able to

CO1. Analyze the dielectric behavior of electric field
CO2. Understand the insulation failure
CO3. Diagnose in high voltage
CO4. Diagnose the faults in power system equipment
CO5. Assess the reliability of power system equipment

Detailed Syllabus:

UNIT-I	**Dielectric behaviour in electric and thermal fields:** Introduction, Mechanism of electrical conduction in matter, Charge storage in dielectric, Non-ideal dielectrics, Behaviour of dielectric in time varying fields, Conduction in dielectrics, breakdown in dielectrics Measurement of dielectric parameter: General, Permittivity and Tan δ, Volume and surface conductivity, Partial discharge measurements, Calibration of PD Measuring circuit and detector, Measurement of dielectric strength
UNIT-II	**Models for electrical insulation failure:** General, Physical models for insulation failure, single stress modelling, Multifactor models. Stochastic nature of electrical insulation failure: General, Statistical aspects of thermal ageing.
UNIT-III	**Concepts in life testing of insulation:** General, Life testing strategies, Miner's theory of cumulative damage, Accelerated stress testing, Censored life testing (CLT).
UNIT-IV	**Diagnostic testing of insulation in high voltage equipment:** General, Concepts in diagnostic testing, End point criteria, Relevance of diagnostic tests and evaluation of test results.
UNIT-V	**Equipment specific diagnostic and reliability assessment:** General, Types of insulation systems in power equipment, Equipment specific condition monitoring and diagnostic testing, Dry type systems, Gas insulated substations, Liquid impregnated and liquid filled systems.

TEXT BOOKS:

1. Reliability and life estimation of power equipment by T.S. Ramu & Chakradhar Reddy "New age international publishers"

Teaching Strategies:

The teaching strategy is planed through the lectures, tutorials and team based home works. Exercises are assigned to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

Teacher's Assessment: Teacher's Assessment based on assignments

EE51006: HVDC and FACTS (Program Elective III)		
Teaching Scheme	**Examination Scheme**	
Lectures : 3 Hrs/Week	Test	: 20 Marks
Tutorial : 0 Hr/Week	Teachers Assessment	: 20 Marks
Credits : 03	End Sem Exam	: 60 Marks

Course Objectives:

The objectives of the course are to-

1. Understand the configuration and working of HVDC systems
2. Analyze harmonics and to understand the different protection schemes of HVDC systems
3. Understand operating principle of FACTS devices
4. Analyze the operation of shunt, series and combined compensators
5. Impart knowledge on application of shunt, series and combined compensator to improve AC transmission.

Course Outcomes:

After completing the course, students will able to:

CO1	Review the HVDC transmission systems, design the HVDC converters
CO2	Identify the suitable methods to review and reduce the harmonics in HVDC system
CO3	Analyze the reactive power compensation in AC transmission systems
CO4	Analyze suitable compensation for AC transmission systems
CO5	Apply the concepts to electrical power transmission systems

Detailed Syllabus:

UNIT-1	**Introduction:** Comparison of AC and DC transmission systems, application of DC transmission, types of DC links, layout of a HVDC converter station. HVDC converters, pulse number, analysis of Gratez circuit with and without overlap, converter bridge characteristics, equivalent circuits or rectifier and inverter configurations of twelve pulse converters
UNIT-2	**Converter & HVDC System Control:** Principles of DC Link Control — Converters Control Characteristics — system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link.
UNIT-3	**Harmonics, Filters and Reactive Power Control:** Introduction, generation of harmonics, AC and DC filters. Reactive Power Requirements in steady state, sources of reactive power, static VAR systems. **Power Flow Analysis in AC/DC Systems:** Modeling of DC/AC converters, Controller Equations-Solutions of AC/DC load flow —Simultaneous method-Sequential method.
UNIT-4	**Introduction to FACTS:** Flow of power in AC parallel paths and meshed systems, basic types of FACTS controllers, brief description and definitions of FACTS controllers. **Static Shunt Compensators:** Objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators, SVC and STATCOM, comparison between SVC and STATCOM.
UNIT-5	**Static Series Compensators** : Objectives of series compensation, variable impedance type-thruster switched series capacitors (TCSC), and switching converter type series compensators, static series synchronous compensator (SSSC)-power angle characteristics-basic operating control schemes.
UNIT-6	**Combined Compensators:** Introduction, unified power flow controller (UPFC), basic operating principle, independent real and reactive power flow controller, control structure.

Text Books:

1. HVDC Transmission, S. Kamakshaiah, V. Kamaraju, The Mc-Graw Hill
2. HVDC power Transmission systems by K.R. Padiyar, Wiley Eastern Limited
3. Understanding of FACTS by N.G. Hingorani & L. Gyugyi, IEEE Press.
4. Flexible AC Transmission Systems (FACTS) Young Huasong & Alian T. hons, The Institution of Electrical Engineers, IEE Power and Energy Series 30.

Teacher Assessment:

Assessments will be based on any two following components -

1. Assignment
2. MCQ
3. PPT
4. Surprise Test

Approved in XIX th Academic
Council, dated 27/07/2018

Program Elective IV

EE52018 : DIGITAL SIGNAL PROCESSING (Program Elective- IV)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Test	: 20 Marks
Tutorial	: 0 Hrs/Week	Teachers Assessment	: 20 Marks
Credits	: 3	End Semester Exam	: 60 Marks

Course Description: This is the course in Electrical Engineering which introduces the basic concepts and techniques for processing signals on a computer and be familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.

Course Objectives:

The objectives of the course are to

1. Introduce the basic concepts and techniques for processing signals on a computer.
2. Be familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.
3. Emphasizes intuitive understanding and practical implementations of the theoretical concepts.

Course Outcomes

After completing the course, students will able to:

CO1	Represent discrete-time signals analytically and visualize them in the time domain.
CO2	Understand the meaning and implications of the properties of systems and signals.
CO3	Understand the Transform domain and its significance and problems related to computational complexity.
CO4	Be able to specify and design any digital filters using MATLAB.

Detailed Syllabus:

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 Bandpass Signals, Analog Low pass Filter Design, Design of Analog Highpass, Bandpass, and Bandstop 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, Tuneable 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

Text Books:

1. R. Babu. , "Digital Signal Processing", Laxmi Publication Ltd.
2. A. Ambardar, "Digital Signal Processing: A Modern Introduction", Penram International Publishing (India) Pvt. Ltd.

Reference Books:

2. Proakis, "Digital Signal Processing", Pearson Education Limited
3. Oppenheim and Schafer, "Discrete-Time Signal Processing", Prentice-Hall, 1989.
4. Rabiner, R. Lawrence, "Theory and Application of Digital Signal Processing", Gold, Bernard, Prentice-Hall

Teacher's Assessment: Assessments should be based on -

1. Assignment — 10 Marks
2. MCQ — 10 Marks

Approved in XIX th Academic Council, dated 27/07/2018

EE52019 : OPTIMIZATION TECHNIQUES (Program Elective- IV)		
Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs/Week	**Test**	**: 20 Marks**
Tutorial: 0 Hrs/Week	**Teachers Assessment**	**: 20 Marks**
Credits:3	**End Semester Exam**	**: 60 Marks**

Course Description: Electrical Power Systems is growing at a faster pace. An Electrical Engineer should be able to solve the optimization problems in electrical engineering. This course is aimed to cover the fundamental of LPP and NLPP optimization techniques for solving engineering problems.

Course Objectives:

The objectives of the course are to

1. Introduce the fundamental concepts of Optimization Techniques;
2. Make the learners aware of the importance of optimizations in real scenarios;
3. Provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

Course Outcomes

After completing the course, students will able to:

CO1	formulate optimization problems
CO2	understand and apply the concept of optimality criteria for various type of optimization problems
CO3	solve various constrained and unconstrained problems in single variable as well as multivariable;
CO4	apply the methods of optimization genetic algorithm for real life situation
CO5	apply the methods of optimization techniques for the application in power system engineering

Detailed Syllabus:

Unit 1	Introduction: Concept of optimization and classification of optimization techniques, formation of optimization problems Linear Programming : Standard form of LPP Simplex Method of solving LPP, duality, decomposition principle, transportation problem and application of LPP to Electrical Engineering
Unit 2	Non-Linear Problem (NLP) : One dimensional methods, Elimination methods, Interpolation methods, Unconstrained optimization techniques-Direct search and Descent methods, constrained optimization techniques, direct and indirect methods
Unit 3	Dynamic Programming: Multistage decision processes, concept of sub-optimization and principle of optimality, conversion of final value problem into an initial value problem.
Unit 4	Genetic Algorithm: Introduction to genetic Algorithm, working principle, coding of Variables, fitness function. GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm, global optimization using GA
Unit 5	Applications to Power system: Economic Load Dispatch in thermal and Hydro-thermal system using GA and classical optimization techniques, Unit commitment problem, reactive power optimization. Optimal power flow, LPP and NLP techniques to Optimal flow problems.

Text and Reference Books

1. S.S.Rao, "Optimization - Theory and Applications", Wiley-Eastern Limited.
2. David G. Luenberger, "Introduction of Linear and Non-Linear Programming ", Wesley Publishing Company
3. Polak, "Computational methods in Optimization", Academic Press. Pierre D.A, "Optimization Theory with Applications", Wiley Publications.
4. Kalyanmoy deb, "Optimization for Engineering Design: Algorithms and Examples", Kalyanmoy deb, PHI Publication.
5. D.E. Goldberg & Addision, "Genetic Algorithm in Search Optimization and Machine Learning ", Wesley Publication, 1989
6. L.P. Singh, "Advanced Power System Analysis and Dynamics", Wiley Eastern Limited.
7. Hadi Saadat "Power System Analysis ", TMH Publication.
8. Olle I.Elewgerd " Electrical Energy System : An Introduction", TMH Publication, New Delhi.

Teacher's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Teaching Strategies: The teaching strategy is planed through the lectures, tutorials and team based home Assignments.

Approved in XIX th Academic Council, dated 27/07/2018

EE52020: ELECTRIC TRACTION (Program Elective IV)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Test	: 20 Marks
Tutorial	: 0 Hrs/Week	Teachers Assessment	: 20 Marks
Credits	: 03	End Semester Exam	: 60 Marks

Prerequisites:

EE 4039: Estimation Testing and Maintenance

Course Description:

Electric Traction is a one-semester course elective to all fourth year Electrical Engineering students. It is the fundamental course related to Power System Engineering.

Course Objective:

The objectives of the course are to

1. Select proper motor for given load characteristic. Selection of motor based on load characteristic, electrical, mechanical characteristic and service duty.
2. Provides the knowledge of electric traction, ideal requirement of traction motor, operation and control.
3. The impact of electrical characteristic of motor in electric traction system.
4. Knowledge of selection of proper drive for traction
5. Implement recent technology of traction system to Indian railways

Course Outcomes:

After completing the course, students will be able to:

CO1	Apply the knowledge of electrical engineering subjects in different application of industries like manufacturing, maintenance, operation and safety.
CO2	Understand the characteristic of load and selection of derive in industrial sectors.
CO3	Conduct practical and analyze data for proper selection of derive in realistic constrain of load requirement.
CO4	Understand the impact of electrical characteristic of motor in electric traction system.
CO5	Do higher study in the field of modern derives and control and develop traction system for Indian railways

Detailed Syllabus:

Unit 1	**Electric Drives** Type of drives, Nature of load, Section motors, electrical, mechanical , service capacity and rating and Types of Enclosures. Electrical Characteristic: Starting, Operating and running, speed control and braking characteristics of DC motor, three phase induction motor single phase induction motor
Unit 2	**Types of Duties** Type of duty: Continuous, intermittent and short time rating , temperature rise and rating calculations for these duties mechanical features , features of load diagram construction, load equalization & use of flywheel.
Unit 3	**Traction Systems** Requirements of ideal traction system, Systems of track electrification and their comparison, speed time curve, factors affecting on schedule speed, Tractive effort, Factors affecting in energy consumption and specific energy consumption.
Unit 4	**Traction Motors** General features of traction motors, Control of traction motor: starting, speed control and braking of traction motor , Energy returned during regenerative braking ,overhead equipment control gear .

Unit 5	**Recent terminology in traction drives** Analysis and performance characteristics of chopper fed dc motors, Motoring and braking operations, Multiphase chopper, Phase locked loop control of dc drive. Variable voltage variable frequency (VVVF) operation, Voltage source inverter (VSI) fed induction motor drive, Static rotor resistance control, Slip power recovery systems, closed loop control of ac drives, Introduction to field oriented control of ac motors, Recent development in Indian railway traction system technology and its implementation in Indian railways

Text and Reference Books

1. J. B. Gupta, "A Course in Electrical Power"
2. V. V. L. Rao, "Utilization of Electrical Energy", TMH
3. O. E. Taylor, "Utilization of Electrical Energy", TMH
4. S. K. Pillai, "A Course in Electrical Energy", TMH
5. H. Partab, "Art & Science of Utilization of Electrical Energy"

Teacher's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Teaching Strategies:

The teaching strategy planned through the lectures, and team based home works. Exercises assigned weekly to stimulate the students to actively use and revise the learned concepts, which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes emphasized

Special Instructions if any: Nil

EE 52021: OPTIMAL CONTROL SYSTEM (Program Elective IV)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0 Hr/Week	Teachers' Assessment	: 20 Marks
Total Credits	: 3	End -Semester Exam	: 60 Marks

Pre- Requisites: Control System

Course Description: Optimal control is the problem of determining the control function for a dynamical system to minimize a cost related to the system trajectory. The overall aim of the course is to provide an understanding of the main results in calculus of variations and optimal control.

Course Objectives: - The objectives of the course are to

1. Explain the formulation of optimal control problem
2. Explain the minimization of function using calculus of variation
3. Explain the dynamic programming
4. Explain minimization function using two boundary value problem
5. Explain optimal feedback

Unit wise Course Outcomes expected:

Students will be able to

CO1.Formulate optimal control problem
CO2. Minimize the function using calculus of variation
CO3. Solve dynamic programming problem
CO4. Minimize function using two boundary value problem
CO5. Solve optimal feedback problem

Detailed Syllabus:

UNIT-I	**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-II	**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-III	**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-IV	**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-V	**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

Text Books:

1. A. E. Bryson and Y. C. Ho, Applied Optimal Control, Hemisphere/Wiley, 1975.
2. D. E. Kirk, Optimal Control Theory: An Introduction, Prentice-Hall, 1970.
3. B. D. O. Anderson and J. B. Moore, Optimal Control, Prentice-Hall, 1990.

1. Teaching Strategies:

The teaching strategy is planed through the lectures, tutorials and team based home works, NPTEL. Exercises are assigned to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

2. Teacher's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Approved in XIX th Academic Council, dated 27/07/2018

EE51020 POWER SYSTEM RELIABILITY (Program Elective IV)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Test	: 20 Marks
Tutorials	: 0 Hr/Week	Teachers Assessment	: 20 Marks
Total Credits	: 3	End Semester Exam	: 60 Marks

Course Description:
Power System Reliability is a one-semester course as elective to post graduates of Electrical Engineering students. It is the fundamental course related to condition of reliability of power system

Course Objectives:
The objectives of the course are to
1. Study the fundamentals of Generation system, Transmission system and Distribution system reliability analysis
2. Provide comprehensive knowledge on the various aspects of reliability of power system equipments
3. Explain methods of determination of risk indices and system reliability evaluation
4. Knowledge of assessing reliability of single and multi-area

Course Outcomes:
After completing the course, students will be able to:

CO1	Understand the importance of maintaining reliability of power system components
CO2	Apply the probabilistic methods for evaluating the reliability of generation and transmission systems
CO3	Assess the different models of system components in reliability studies..
CO4	Assess the reliability of single area and multi area systems
CO5	Explain reliability of different power system equipments

Detailed Syllabus:

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 , 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	Reliability analysis of different power system equipment : Inclusion of bus bar failures, scheduled maintenance, temporary and transient failures, common mode failures, 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. Transmission System Reliability Evaluation and Composite Reliability Evaluation: Average interruption rate method, Stormy and normal weather effect, The Markov process approach, Two plant single load composite system reliability analysis

Text and Reference 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
3 Electric Energy System Theory by O.I. Elgerd McGraw Hill Higher Education; 2nd edition
4 Power system Analysis by Stevenson and Grainger , McGraw Hill Education; 1 edition
5 Power System Planning by R. L. Sullivan ,Mc-Graw Hill International book company
6 Reliability Modeling in Electric Power Systems by J.Endrenyi A Wiley-Interscience Publication. Author, *J. Endrenyi*. Edition, illustrated. Publisher, Wiley, 1979.
7 Power System Control & Stability by P. Kundur *McGraw-Hill* Education; 1st edition

Teacher's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems Quiz

Teaching Strategies: The teaching strategy is planed through the lectures, tutorials and team based home Assignments.

Program Elective V

CSXXXX: INTERNET OF THINGS (Program Elective V)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs/Week	Test	: 20 Marks
Tutorial	: 0 Hr/Week	Teachers Assessment	: 20 Marks
Credits	: 03	End Sem Exam	: 60 Marks

Syllabus will be available on institute website

EE52022: BIOMEDICAL INSTRUMENTATION (Program Elective V)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0	Teachers Assessment	: 20 Marks
Total Credits	: 03	End Semester Exam	: 60 Marks

Course Description:

Biomedical Instrumentation is a one-semester course elective to all fourth year Electrical Engineering students. It is the fundamental course related to Power System Engineering.

Course Objective:

The objectives of the course are to

1. Provide an acquaintance of the physiology of the heart, lung, blood circulation and circulation respiration. Biomedical applications of different transducers used.
2. Introduce the student to the various sensing and measurement devices of electrical origin.
3. Provide awareness of electrical safety of medical equipments
4. Provide the latest ideas on devices of non-electrical devices.
5. Bring out the important and modern methods of imaging techniques.
6. Provide latest knowledge of medical assistance / techniques and therapeutic

Course Outcomes:

After completing the course, students will be able to:

CO1	Known Physiology and proper transducer for measurement
CO2	Develop set up for measurement of human parameter for measurement
CO3	Select proper transducer for measurement of non electrical
CO4	Analysis medical imaging
CO5	Create a proper therapeutic experiment setup for measurement

Detailed Syllabus:

Unit 1	**PHYSIOLOGY AND TRANSDUCERS** Cell and its structure – Resting and Action Potential – Nervous system: Functional organisation of the nervous system – Structure of nervous system, neurons - synapse – transmitters and neural communication – Cardiovascular system – respiratory system – Basic components of a biomedical system - Transducers – selection criteria – Piezo electric, ultrasonic transducers – Temperature measurements - Fibre optic temperature sensors.
Unit 2	**ELECTRO – PHYSIOLOGICAL MEASUREMENTS** Electrodes –Limb electrodes –floating electrodes – pregelled disposable electrodes -

	Micro, needle and surface electrodes – Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier. ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms. Electrical safety in medical environment: shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipments
Unit 3	**NON-ELECTRICAL PARAMETER MEASUREMENTS** Measurement of blood pressure – Cardiac output – Heart rate – Heart sound – Pulmonary function measurements – spirometer – Photo Plethysmography, Body Plethysmography – Blood Gasanalysers : pH of blood –measurement of blood pCO_2, pO_2, finger-tip oxymeter - ESR, GSR measurements .
Unit 4	**MEDICAL IMAGING** Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems and patient monitoring – Introduction to Biometric systems
Unit 5	**ASSISTING AND THERAPEUTIC EQUIPMENTS** Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers – Lithotripsy

Text and Reference Books

1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd.,2003.
2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II edition, Pearson Education, 2002 / PHI.
3. M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.
4. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley &Sons, 1975.
5. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.
6. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation',Universities press (India) Ltd, Orient Longman ltd, 2000.

Teacher's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student andone of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Teaching Strategies:

The teaching strategy planned through the lectures, and team based home works. Exercises assigned weekly to stimulate the students to actively use and revise the learned concepts, which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes emphasized

Special Instructions if any: Nil

Approved in XIX[th] Academic Council, dated 27/07/2018

Approved in XIX[th] Academic Council, dated 27/07/2018

EE 52023: ELECTRIC VEHICLES (Program Elective V)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0	Teachers Assessment	: 20 Marks
Total Credits	: 03	End Semester Exam	: 60 Marks

Prerequisites: Nil

Course Description: This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. Various aspects of hybrid and electric vehicles such as their configuration, types of electric machines that can be used, energy storage devices, etc. will be covered in this course.

Course Objectives:

The objectives of the course are to introduce and explain

1. The concepts of electrical vehicles and their operation.
2. The basic components of the EV and their design.
3. Power converters & energy storage devices for electrical vehicles

Course Outcomes

After completing the course, students will able to:

CO1	Explain the operation of electrical vehicles.
CO2	Explain Power Converters for Electric and hybrid Vehicles
CO3	Identify the Electrical Machines for Electric and hybrid Vehicles
CO4	Design the components of the electrical vehicles.
CO5	Describe different Energy Storage options for the Electric and hybrid Vehicles

Detailed Syllabus:

Unit 1	History of electric & hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Dynamics of the electric and hybrid electrical vehicles- motion and dynamic equation for vehicles, Vehicle Power Plant and Transmission Characteristics, Basic Architecture of Hybrid Drive Trains and Analysis of Series Drive Train, Power Flow in HEVs, Torque Coupling and Analysis of Parallel Drive Train, Basic Architecture of Electric Drive Trains
Unit 2	Power Converters- DC-DC converters for EV and HEV applications, DC-AC converters in EV & HEV
Unit 3	AC Electrical Machines for hybrid and Electric Vehicles- Induction motors, Permanent Magnet Motors. SRM motors, their control and applications in EV/HEV
Unit 4	Design of Electrical EV/HEV – Principles, Drive cycles and its detail analysis, sizing of electrical machines
Unit 5	Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Text and Reference Books

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", WIELY USA, 2012.
2. Chris Mi, M. Abdul Masrur& David WenzhongGao, "Hybrid Electric Vehicles: Principles and Applications with practical prespective", WIELY, 2011
3. Electric Cars The Future is Now!: Your Guide to the Cars You Can Buy Now and What the Future Holds, by ArvidsLinde, Veloce Publishing, 2010.
4. Abu-Rub, Malinowski and Al-Haddad, "Power Electronics for renewable energy systems, transportation, Industrial Applications", WILEY, 2014.

5. MehrdadEhsani, YiminGao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", Second Edition (Power Electronics and Applications Series) by CRC Press, 2009
6. John Miller, " Propulsion Systems for Hybrid Vehicles," Institute of Electrical Engineers, UK, 2004
7. C.M. Jefferson & R.H. Barnard, " Hybrid Vehicle Propulsion," WIT Press, 2002
8. Iqbal Husain, "Electric and Hybrid Vehicles – Design Fundamentals," CRC Press, 2010
9. James Larminie and John Lowry, " Electric Vehicle Technology Explained, " Oxford Brookes University, Oxford, UK, 2003

Teacher's Assessment: Teachers Assessment of 20 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. MCQ
3. Simulations problems
4. Quiz

Teaching Strategies: The teaching strategy is planed through the lectures, tutorials and team based home Assignments

Approved in XIX^th Academic Council, dated 27/07/2018

EE 52024 : EMBEDDED SYSTEMS (Program Elective V)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs/Week	Class Test	: 20 Marks
Tutorial	: 0 Hr/Week	Teachers' Assessment	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Course Description:

The goal of the course is to teach the concepts C Language and object oriented programming, PIC architecture and peripheral interfacing. To read and understand the C and C++ programming, the course focuses on how to write program and develop the applications.

Course Objectives: The objectives of the course are to

1. Introduce to the architecture of embedded system
2. Explain various devices and communication system in network
3. Explain programming concept in C++
4. Explain real time operating concept
5. Explain the case studies in RTOS

Unit wise Course Outcomes expected:

Students will be able to

CO1. Understand the fundamentals of embedded systems and compare various architecture of embedded systems.
CO2. Develop program in C
CO3. Develop program in C++
CO4. Write assembly language programme for PIC microcontroller
CO5. Write the I/O and timers/counter programming

Detailed Syllabus:

UNIT-I	**Embedded system introduction:** Introduction to embedded system, embedded system architecture, classifications of embedded systems, challenges and design issues in embedded systems, fundamentals of embedded processor and microcontrollers, CISC vs. RISC, fundamentals of Vonneuman/Harvard architectures, types of microcontrollers, selection of microcontrollers.
UNIT-II	Concepts of C programming C concepts and programming- data types, advanced data types- register, constants, IO operations, operators, operator precedence and associatively, Conditional statements & loops, arrays, single and double dimensional arrays, stings and string operations. Functions: Parameter passing-Pass by Value, Pass by Reference; creating modular programs using functions, Recursive functions. Structures & Unions: declaration, accessing members of structure, difference between structure and union, User Defined Data Types, Enumerated data type. Pointers: pointer basics and concepts, arrays and pointer relation, passing pointers to functions, dynamic memory allocation. Files and file operations. Linked lists, stacks and queues. Pre-processor directives, command line arguments.
UNIT-III	Object oriented programming Differences between C and C++,Fundamentals of object oriented programming; OOP vs.Procedure oriented programming, OOP concepts:classes, objects, abstraction, polymorphism, inheritance, data binding and encapsulation. Basics of C++: features of C++, data types, standard I/O, arrays and strings in C++. Classes in C++, instantiation, creating objects and object scope, data abstraction, data encapsulation, constructors and destructors, methods and access

	modifiers, function and operator overloading Inheritance-Base and Derived classes, Inheritance types, Scope Resolution operator; polymorphism and virtual functions, exception handling
UNIT-IV	PIC Architecture Introduction to PIC microcontrollers, PIC architecture, comparison of PIC with other CISC and RISC based systems and microprocessors, memory mapping, assembly language programming, addressing modes, instruction set.
UNIT-V	I/O Programming PIC I/O ports, I/O bit manipulation programming, timers/counters, programming to generate delay and wave form generation, I/O programming, LEDs, 7segment LED's, LCD and Keypad interfacing.

TEXT/ REFERENCE BOOKS:

1. Rajkamal, *"Embedded Systems Architecture, Programming and Design"*, TMH, 2003

2. Wayne Wolf, "*Modern VLSI Design*", 2nd Edition, Prentice Hall,1998

3. Steve Heath, *"Embedded Systems Design"*, Second Edition-2003, Newnes

4. David E. Simon, *"An Embedded Software Primer"*, Pearson Education Asia, First Indian Reprint 2000

5. Wayne Wolf, "Computers as Components; Principles of Embedded Computing System Design", Harcourt India, Morgan Kaufman Publishers, First Indian Reprint

Instructor reference material

6. Chuck Helebuyck "Programming PIC microcontrollers with PIC basic"

7. Yashvant P. Kanetkar "Let Us C"

8. E Balaguruswami "Object-Oriented Programming With C++"

9. Brian W. Kernighan and Dennis M. Ritchie "The C programming Language"

10. Milan Verle "PIC Microcontrollers-programming in Basic"

11. http://nptel.ac.in/syllabus/syllabus_pdf/117106110.pdf

1. Teaching Strategies:

The teaching strategy is planed through the lectures, tutorials and team based home works. Exercises are assigned to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

2. Teacher Assessments:

Teacher's Assessment based on one of the /or combination of the few of the following.

1. Multiple choice question
2. PPT presentation
3. Assignments

Approved in XIX[th] Academic Council, dated 27/07/2018

EE 51023: ENGINEERING MATERIALS (Program Elective V)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs/Week	Class Test I	: 20Marks
Tutorial	: 0 Hrs/Week	Teacher Assessment	: 20 Marks
Total Credits	: 3	End -Semester Exam	: 60 Marks

Course Description: The purpose of this course is to teach students the fundamentals of Engineering Materials.

Course Objectives:

The objectives of the course are to

1. Know the fundamental science and engineering principles relevant to materials.
2. Understand the relationship between nano/microstructure, characterization, properties and processing and design of materials.
3. Have the experimental and computational skills for a professional career or graduate study in materials.
4. Possess knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.

Course Outcome:

After completion of this course students will be able to

CO1. Apply core concepts in Materials Science to solve engineering problems.
CO2. . Be knowledgeable of contemporary issues relevant to Materials Science and Engineering.
CO3. Select materials for design and construction.
CO4. Understand the importance of life-long learning.
CO5. Design and conduct experiments, and to analyze data.
CO6. Understand the professional and ethical responsibilities of a materials scientist and engineer.
CO7. Work both independently and as part of a team.
CO8. Possess the skills and techniques necessary for modern materials engineering practice

UNIT-I	**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 thermocouple.
UNIT-II	**Dielectric Properties:** Effect of a dielectric on the behaviour of a capacitor, polarization, Frequency dependence of electronic polarisability, 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-III	**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-IV	**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-V	**Materials for electric components:** Introduction, resistors, capacitors, inductors, relays **Mechanical properties**: The stress/strain relationship, plastic behaviour, block slip theory, hardening, ductility

Text Books :

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

Teaching Strategies:

The teaching strategy is planed through the lectures, tutorials and team based home works. Exercises are assigned to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

Teacher's Assessment: Teacher's Assessment based on one of the /or combination of the few of the following.

1. Multiple choice question
2. PPT presentation

Approved in XIX th Academic Council, dated 27/07/2018

EE61001: RENEWABLE ENERGY TECHNOLOGY (Open Elective)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	Class Test	: 20Marks
Tutorial	: 0	Teacher's Assessment	: 20 Marks
Total Credits	: 03	End -Semester Exam	: 60 Marks

Pre-Requisites: Engineering Physics, Electrical Machines, Power Systems

Course Description:
In this curriculum, students will be explored to Renewable Energy Technologies such as Wind energy, Solar energy. They will be introduced to concepts of fuel cells and biomass energy.

Course Objectives:
The objectives of the course are to learn
1. Different types of energy sources
2. Various solar PV technologies and its characteristics
3. Various solar thermal technologies and its applications
4. Wind energy technologies and its operations
5. Grid integration of wind energy systems and its associated issues

Course Outcomes:
After completing the course, students will able to

CO1.	Elaborate different types of energy sources
CO2	Explain various solar PV technologies and its characteristics and solve numerical on it
CO3	Describe various solar thermal technologies and its uses in various applications
CO4	Discuss wind energy technologies and explain its operations
CO5	Explain grid integration of wind energy systems and its associated issues

Detailed Syllabus:

UNIT-I	**Basics of Energy:** Energy and Power, Hubert peak, Energy Scenario in India, Environmental impact of fossil fuels, Different types of energy sources - solar, wind, tidal, geothermal, wave energy, Introduction to fuel cells and Biomass
UNIT-II	**Solar PV Technology:** Amorphous mono-crystalline, poly-crystalline, V-I characteristics, Shading impact, PV module, Array, Maximum Power Point Tracking, Grid connected and standalone systems
UNIT-III	**Solar Thermal Technology:** Solar Spectrum, Solar Geometry, Sun Earth angles, Solar radiation at given locations, Flat plate collector, Parabolic trough, Central receiver, parabolic dish, Fresnel, solar pond, solar still
UNIT-IV	**Wind Energy Technology:** History of wind power, types of wind turbines, power in the wind, Betz limit, Tip speed ratio, stall and pitch control, wind speed statistics, probability distribution, wind generator topologies, voltage and reactive power control, power quality standard for wind turbines
UNIT-V	**Grid Integration of Wind Energy:** Wind farms, real and reactive power regulation, voltage and frequency operating limits, wind farm behavior during grid disturbances, power system interconnection, Economic aspects

Text and Reference Books:

1. Thomas Ackermann, Editor, "Wind Power in Power Systems", John Willy and sons ltd., 2005,ISBN 0-470-85508-8.
2. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", John Willy and sons,2004,ISBN0-471-28060-7.
3. S. P. Sukhatme, "Solar Energy", Tata McGrew Hill, second edition, 1996, ISBN 0-07-462453-9.

Approved in XIXth Academic Council, dated 27/07/2018

4. Chetan Singh Solanki, "Solar Photovoltaics", fundamental, technologies and applications, PHI- second edition, 2011.

5. Siegfried Heier, "Grid integration of wind energy conversion systems" John Willy and sons ltd.2006.

6. Mullic and G.N.Tiwari, "Renewable Energy Applications", Pearson Publications.

7. John A. Duffie, William A. Beckman, "Solar Engineering of Thermal Processes", Wiley Inter science Publication, 1991

Teacher's Assessment: Teacher's Assessment is based on one of the following.

1. Assignments
2. Models/ Presentations
3. multiple choice questions test
4. Quiz

EE 62001 : DISSERTATION PHASE - I		
Teaching Scheme	**Examination Scheme**	
Practical : 20 Hrs/Week	Term Work	: 50 Marks
Credits : 10	Viva-voce	: 50 Marks
	Total	: 100 Marks

Student will present 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
2. Guide- Member
3. Subject expert from institute/industry-member

The committee will monitor the quality of the dissertation work.

EE62002: DISSERTATION PHASE - II		
Teaching Scheme	**Examination Scheme**	
Practical : 32 Hrs/Week	Term Work	: 100 Marks
Credits : 16	Viva-voce	: 100Marks
	Total	: 200 Marks

Student will present 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
2. Guide- Member
3. Subject expert from institute/industry-member

The committee will monitor the quality of the dissertation work.