SYLLABUS

Bachelor of Technology - Electrical Engineering

Department of Electrical Engineering
Z. H. College of Engineering and Technology
Aligarh Muslim University, Aligarh - INDIA

PROGRAM EDUCATIONAL OBJECTIVES (PEOS) OF B. TECH. PROGRAMME:

PEO 1: Students will have a successful technical and professional careers, including supportive and leadership roles on multidisciplinary teams.

PEO 2: Students will be able to acquire, use and develop skills as required for effective professional practices.

PEO 3: Students will be able to attain holistic education that is an essential prerequisite for being a responsible member of society.

PEO 4: Students will be engaged in life-long learning, to remain abreast in their profession and be leaders in our technologically vibrant society.

PROGRAM OUTCOMES (POS) OF B. TECH. PROGRAMME:

a. Students will demonstrate knowledge of mathematics, science and Electrical Engineering.
b. Students will demonstrate an ability to identify, formulate and solve Electrical Engineering problems.
c. Students will demonstrate an ability to design electrical and electronic circuits and conduct experiments with electrical systems, analyze and interpret data.
d. Students will demonstrate an ability to design a system, component or process as per needs and specification within realistic constraints.
e. Students will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
f. Students will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
g. Students will demonstrate knowledge of professional and ethical responsibilities.
h. Students will be able to communicate effectively.
i. Students will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
j. Students will develop confidence for self-education and ability to engage in life-long learning.
k. Students will actively participate and succeed in competitive examinations.

CURRICULUM SUMMARY: B.TECH.

CREDITS ALLOCATED TO DIFFERENT COURSE CATEGORIES IN DIFFERENT BRANCHES

Course Category/Branch	CIVIL	CHEMICAL	COMPUTER	ELECTRICAL	ELECTRONICS	MECHANICAL	PETROCHEMICAL
Departmental Core (DC)	109	100.5	87	99	98	95.5	103
Departmental Elective (DE)	16	16	24	21	20	20	16
Basic Sciences (BS)	25	26	31	26	27	27	27
Engg. Science and Arts (ESA)	30	34.5	38	34	35	35.5	34
Open Elective (OE)	8	8	8	8	8	8	8
Humanities (HM)	12	15	12	12	12	14	12

TOTAL CREDITS: 200

Course Structure: B.Tech. (Valid for students admitted from year 2017 onwards)

First Year-All Branches (Sections A1A, A1B & A1C)

Semester 1:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	BS	AMS1110	Applied Mathematics-I	3	1	0	4	15	25	60	100	
2	BS	ACS1110	Applied Chemistry	3	1	0	4	15	25	60	100	
3	ESA	EEA1110	Principles of Electrical Engineering	2	1	0	3	15	25	60	100	
4	ESA	CEA1110	Environmental Studies	2	1	0	3	15	25	60	100	
5	ESA	MEA1110	Engineering Thermodynamics	3	1	0	4	15	25	60	100	
6	BS	ACS1910	Applied Chemistry Lab	0	0	3	1.5	60		40	100	
7	ESA	COA1910	Computer Programming Lab	0	0	3	1.5	60		40	100	
8	ESA	MEA1910	Engineering Graphics Lab	0	1	2	2	60		40	100	

TOTAL CREDITS: 23

Semester 2:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	BS	AMS1120	Applied Mathematics-II	3	1	0	4	15	25	60	100	
2	BS	APS1110	Applied Physics	3	1	0	4	15	25	60	100	
3	ESA	ELA1110	Principles of Electronics Engineering	2	1	0	3	15	25	60	100	
4	ESA	CEA1120	Strength of Materials	2	1	0	3	15	25	60	100	
5	ESA	MEA1120	Engineering Mechanics	2	1	0	3	15	25	60	100	
6	HM	EZH1110	English	2	1	0	3	15	25	60	100	
7	BS	APS1910	Applied Physics Lab	0	0	3	1.5	60		40	100	
8	ESA	MEA1920	Manufacturing Process Lab	0	0	3	1.5	60		40	100	

TOTAL CREDITS: 23

First Year -All Branches (Sections A1D, A1E & A1F)

Semester 1:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	BS	AMS1110	Applied Mathematics-I	3	1	0	4	15	25	60	100	
2	BS	APS1110	Applied Physics	3	1	0	4	15	25	60	100	
3	ESA	ELA1110	Principles of Electronics Engineering	2	1	0	3	15	25	60	100	
4	ESA	CEA1120	Strength of Materials	2	1	0	3	15	25	60	100	
5	ESA	MEA1120	Engineering Mechanics	2	1	0	3	15	25	60	100	
6	HM	EZH1110	English	2	1	0	3	15	25	60	100	
7	BS	APS1910	Applied Physics Lab	0	0	3	1.5	60		40	100	
8	ESA	MEA1920	Manufacturing Process Lab	0	0	3	1.5	60		40	100	

TOTAL CREDITS: 23

Semester 2:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	BS	AMS1120	Applied Mathematics-II	3	1	0	4	15	25	60	100	
2	BS	ACS1110	Applied Chemistry	3	1	0	4	15	25	60	100	
3	ESA	EEA1110	Principles of Electrical Engineering	2	1	0	3	15	25	60	100	
4	ESA	CEA1110	Environmental Studies	2	1	0	3	15	25	60	100	
5	ESA	MEA1110	Engineering Thermodynamics	3	1	0	4	15	25	60	100	
6	BS	ACS1910	Applied Chemistry Lab	0	0	3	1.5	60		40	100	
7	ESA	COA1910	Computer Programming Lab	0	0	3	1.5	60		40	100	
8	ESA	MEA1910	Engineering Graphics Lab	0	1	2	2	60		40	100	

TOTAL CREDITS: 23

B.TECH: ELECTRICAL ENGINEERING

Semester 3:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	BS	AMS2230	Higher Mathematics	3	1	0	4	15	25	60	100	
2	BS	APS2050	Electrical Engineering Materials	2	1	0	3	15	25	60	100	
3	DC	EEC2110	Electrical Machines-I	3	1	0	4	15	25	60	100	
4	DC	EEC2710	Circuit Theory	3	1	0	4	15	25	60	100	
5	DC	EEC2720	Electromagnetic Field Theory	3	1	0	4	15	25	60	100	
6	DC	EEC2730	Signals & Systems	2	1	0	3	15	25	60	100	
7	HM	EZHxxxx	Communication Skills Lab	0	1	2	2	60	---	40	100	
8	DC	EEC2910	Electrical Machines Lab I	0	1	2	2	60	---	40	100	

TOTAL CREDITS: 26

Semester 4:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	ESA	ELA2010	Logic & Digital Circuit	3	1	0	4	15	25	60	100	
2	HM	MEH2450	Engineering Economy & Management	3	1	0	4	15	25	60	100	
3	DC	EEC2120	Electrical Machines II	3	1	0	4	15	25	60	100	EEC2110
4	DC	EEC2210	Power Electronics-I	3	1	0	4	15	25	60	100	
5	DC	EEC2310	Power System Engineering	3	1	0	4	15	25	60	100	
6	DC	EEC2510	Electrical Measurement	3	1	0	4	15	25	60	100	
7	DC	EEC2920	Electrical Machines Lab II	0	1	2	2	60	---	40	100	
8	DC	EEC2930	Circuits and Measurements Lab	0	1	2	2	60	---	40	100	

TOTAL CREDITS: 28

B.TECH: ELECTRICAL ENGINEERING

Semester 5:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	OE	--------	OE-I	3	1	0	4	15	25	60	100	
2	ESA	ELA3020	Fundamentals of Communication Engineering	3	1	0	4	15	25	60	100	
3	DC	EEC3210	Power Electronics-II	3	1	0	4	15	25	60	100	EEC2210
4	DC	EEC3310	Power System Analysis	3	1	0	4	15	25	60	100	EEC2310
5	DC	EEC3510	Electrical & Electronic Instr.	2	1	0	3	15	25	60	100	
6	DC	EEC3610	High Voltage Engineering	2	1	0	3	15	25	60	100	
7	ESA	ELA3910	Electronics Engg. Lab	0	1	2	2	60	---	40	100	
8	DC	EEC3910	Power Electronics Lab	0	1	2	2	60	---	40	100	

TOTAL CREDITS: 26

Semester 6:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	HM		Elective Course under Humanities Category	2	1	0	3	15	25	60	100	
2	DC	EEC3110	Electrical Drives	3	1	0	4	15	25	60	100	EEC2120, EEC3210
3	DC	EEC3220	New and Renewable Energy Sources	3	1	0	4	15	25	60	100	
4	DC	EEC3310	Electrical Power Gen. & Utilization	3	1	0	4	15	25	60	100	
5	DC	EEC3410	Dynamic System Analysis	3	1	0	4	15	25	60	100	
6	DC	EEC3710	Microcontroller Systems and Appl.	3	1	0	4	15	25	60	100	ELA2010
7	DC	EEC3920	Power System and High Voltage Lab	0	1	2	2	60	---	40	100	
8	DC	EEC3930	Instrumentation Lab	0	1	2	2	60	---	40	100	

TOTAL CREDITS: 27

B.TECH: ELECTRICAL ENGINEERING

Semester 7:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	DE	--------	DE-1	2	1	0	3	15	25	60	100	
2	DE	--------	DE-2	2	1	0	3	15	25	60	100	
3	DE	--------	DE-3	2	1	0	3	15	25	60	100	
4	DC	EEC4310	Power System Protection	3	1	0	4	15	25	60	100	EEC3310
5	DC	EEC4410	Control Systems	3	1	0	4	15	25	60	100	EEC3410
6	DC	EEC4910	Power System Protection Lab	0	1	2	2	60	---	40	100	
7	DC	EEC4920	Control Lab	0	1	2	2	60	---	40	100	
8	DC	EEC4930	Electric Machine Design	0	1	2	2	60	---	40	100	EEC2120
9	DC	EEC4940	Power System Design	0	1	2	2	60	---	40	100	EEC3310
10	DC	EEC4980	Project Phase-I	0	2	0	2	60	---	40	100	

TOTAL CREDITS: 27

Semester 8:

S.No.	Crs. Cat.	Crs No.	Course title	Contact Periods			Credits	Marks			Total	Pre-Requisite Courses
				L	T	P		Crs.-Work	Mid-Sem	End-Sem		
1	OE	--------	OE-2	3	1	0	4	15	25	60	100	
2	DE	--------	DE-4	2	1	0	3	15	25	60	100	
3	DE	--------	DE-5	2	1	0	3	15	25	60	100	
4	DE	--------	DE-6	2	1	0	3	15	25	60	100	
5	DE	--------	DE-7	2	1	0	3	15	25	60	100	
6	DC	EEC4990	Project Phase-II	0	4	0	4	60	---	40	100	EEC4980

TOTAL CREDITS: 20

DEPARTMENT OF ELECTRICAL ENGINEERING
Z. H. COLLEGE OF ENGINEERING & TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY ALIGARH

New B.Tech. Structure as approved in BOS dated 09.05.2017 and 26.05.2017

B.Tech. 1st year syllabus
(Approved in BOS dated 26.05.2017)

Course Title	**Principles of Electrical Engineering**
Course Number	**EEA1110**
Credits	3
Course Category	DC
Prerequisite Courses	None
Contact Course	2-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The objective of this course is to introduce the basic concepts of electrical engineering
Course Outcomes	Course Outcomes: After successful completion of this course students will be able to: 1. Solve the problems of AC/DC circuits and transients. 2. Solve the problems of magnetic circuits and single-phase transformers. 3. Describe the basics of Electrical Machines/Power Systems and solve related engineering problems.

SYLLABUS	**No. of Lectures**
UNIT-1. ELECTRIC CIRCUITS Single phase ac circuits; concept of phasor, RLC series and parallel circuits, Network theorems for ac & dc circuits, Three phase ac circuit; star and delta connections, Three phase power, Transients in Electric circuits	12
UNIT-2. MAGNETIC CIRCUITS & TRANSFORMERS **Magnetic circuits:** Definitions, Magnetization & Magnetic losses, Equivalence of magnetic & electric circuits. Series & parallel magnetic circuits. **Transformers:** Construction & principle of operation of single-phase transformer; equivalent circuit, calculation of losses, efficiency and voltage regulation.	12
UNIT-3. INTRODUCTION TO ELECTRIC MACHINES & POWER SYSTEM **Electrical Machines:** Rotating magnetic field, Alternator construction, principle of operation & emf equation. Construction & principle of operation of 3-phase Induction motor. **Basics of Power System:** Elements of power system; Generation, transmission & distribution line diagram, Electric power generation, Concept of Green energy.	12
TOTAL:	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. Vincent Del Toro, "Electrical Engineering Fundamentals"., 2nd edition, Pearson Education, 2015** (Textbook).
2. Jimmie J. Cathey, Syed A. Nasar, J. Cathey J., "Basic Electrical Engineering", Schaum's Outlines, Tata McGraw Hill, 1997.
3. Ashfaq Hussain, "Fundamentals of Electrical Engineering", Dhanpat Rai & Co., 3rd edition, 2007.

Program Outcomes (POs): B. Tech. Programme

a. Students will demonstrate knowledge of mathematics, science and Electrical Engineering.
b. Students will demonstrate an ability to identify, formulate and solve Electrical Engineering problems.
c. Students will demonstrate an ability to design electrical and electronic circuits and conduct experiments with electrical systems, analyze and interpret data.
d. Students will demonstrate an ability to design a system, component or process as per needs and specification within realistic constraints.
e. Students will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
f. Students will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
g. Students will demonstrate knowledge of professional and ethical responsibilities.
h. Students will be able to communicate effectively.
i. Students will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
j. Students will develop confidence for self-education and ability to engage in life-long learning.
k. Students will actively participate and succeed in competitive examinations.

CO-PO Mapping:

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x								x	x
CO 2	x	x								x	x
CO 3	x	x							x	x	x

B.Tech. 2nd year Syllabus
(Approved in BOS dated 23.05.2018 and 20.11.2018)

Course Title	**Signals and Systems**
Course Number	**EEC2730**
Credits	3
Course Category	DC
Prerequisite Courses	None
Contact Course	2-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The Objective of this course is to build a firm foundation of Signals and Systems.
Course Outcomes	Course Outcomes: After successful completion of this course students will be able to: 4. State and apply time-domain properties of continuous-time (CT) and discrete-time (DT) linear time-invariant (LTI) systems. 5. Describe systems using linear differential and difference equations. 6. Understand the notion of an impulse response and the process of convolution between signals and its implication for analysis of LTI systems. 7. Ability to apply the Fourier series, Fourier transform in CT/DT signal analysis. 8. Analyze and characterize the system using Laplace and Z-transform.

SYLLABUS	**No. of Lectures**
UNIT I: INTRODUCTION TO SIGNALS AND SYSTEMS Classification of signals, Basic operation on signals, Elementary signals, Representation and Classification of continuous and discrete time systems, Properties of systems, System Model: Input-Output Description.	08
UNIT II: TIME-DOMAIN ANALYSIS OF SYSTEMS System representation through differential equations and difference equations, Impulse response and its properties for LTI systems, Convolution and its properties, Sampling and recovery of signals.	10
UNIT III: FOURIER REPRESENTATION FOR SIGNALS Review of Trigonometric Fourier Series, Exponential Fourier Series, Fourier Transform and its properties, Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT).	10
UNIT IV: SYSTEM ANALYSIS USING LAPLACE TRANSFORM AND Z-TRANSFORM Laplace Transform and its properties, Inversion of Laplace Transform, Solving Differential Equations with Initial Conditions, Unilateral and Bilateral Z-Transform and its Properties, Region of Convergence, Inversion of Z-Transform Transform analysis of LTI systems.	10
TOTAL:	**38**

SUGGESTED READING / TEXTS / REFERENCES

1. A. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Ed.
2. *S. Haykin and B. V. Veen, Signals and Systems, John Wiley and Sons.
3. T K Rawat, Signals and Systems, Oxford University Press.
4. B P Lathi, Signal Processing and Linear Systems, Oxford University Press.

EA2030: Electrical Engineering (For Chemical Engineers)

Course Title	Electrical Engineering
Course Number	EEA2030
Credits	3
Course Category	ESA
Prerequisite Courses	None
Contact Course	3-0-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The objectives of the course are to provide the students a firm foundation of electrical - mechanical machines, their construction and characteristics, electrical measurements, different metering techniques and architecture of microprocessors.
Course Outcomes	After successful completion of this course students will be able to: 1. Classify different AC machines, analyse their characteristics and their application including speed control. 2. Classify different DC machines, analyse their characteristics and their application including speed control. 3. Measure electrical power and apply different meters in electrical system. 4. Understand basic programming of Microprocessor.

SYLLABUS	**No. of Lectures**
UNIT I: AC MACHINES Construction of three-phase transformers, three-phase induction motors and their speed control techniques: voltage and voltage/frequency control, universal and servo motors, synchronous motors.	10
UNIT II: DC MOTORS Construction and types, basic principles of operation, torque expression, characteristics, need of starter, PM motors, speed control, series, shunt and separately excited motors.	10
UNIT III: ELECTRICAL MEASUREMENT Principle of electrical measurement, errors in measurement, measurement of power in three-phase circuits, hall-effect current probes and power meters, static energy meters.	10
UNIT IV: DIGITAL CIRCUIT BASICS Introduction to Microprocessor, Registers, ROM, RAM, Microprocessors Architecture, Basics of Assembly language programming.	10
TOTAL:	**40**

SUGGESTED READING / TEXTS / REFERENCES

1. Nagrath & Kothari, "Electrical Machines: Tata-McGraw Hill," New Delhi.
2. B. Ram, "Fundamental of Microprocessors and Microcomputers," Dhanpat Rai & Sons Publications New Delhi.
3. A.K. Sawhney, "A Course in Electrical & Electronic Measurement and Instrumentation," Dhanpat Rai & Sons, New Delhi.
4. Rangan, Mani & Sarma, "Electrical Instrumentation," TMII, Delhi

EEA2010: Electrical Engineering (for Electronics Engineering Students)

Course Title	Electrical Engineering
Course Number	EEA2010
Credits	4
Course Category	ESA
Prerequisite Courses	EEA1110
Contact Course	3-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce the basic concepts of DC Motor, Induction Motor. Synchronous and Special Machines. To introduce the basics of power transmission, distribution and utilization.
Course Outcomes	At the end of the course the students will be able to: 1. Analyze the construction, characteristics & Applications of various types of DC motors. 2. Understand the working principle, characteristics & Speed Control of 3 phase Induction motors. 3. Understand the working principle and performances of synchronous machines and know about various other special machines and their applications. 4. Know the basics about the transmission lines, power cables, HVDC transmission, distribution system and traction.

SYLLABUS	**No. of Lectures**
UNIT I: DC MOTORS Construction, working principle and classification, emf and torque equation, characteristics, speed control, starters.	11
UNIT II: INDUCTION MOTORS Introduction, principle of operation, equivalent circuit, torque equation, torque slip characteristics, speed control and starting, applications.	11
UNIT III: SYNCHRONOUS AND SPECIAL MACHINES Introduction, EMF equation, circuit model, power developed in cylindrical rotor synchronous machines, introduction and working principle of synchronous motor, construction and working of stepper motor, servomotor and permanent magnet motors & their applications.	12
UNIT IV: TRANSMISSION, DISTRIBUTION AND UTILIZATION Introduction to power system, Classification and representation of transmission line, voltage regulation and efficiency, corona and radio interference, power cables, types, construction, electrical stress and grading, introduction to HVDC transmission, Distribution and Utilization: Types of distribution systems: single phase, three phase four wire system, Substations, traction supply system.	13
TOTAL:	**47**

SUGGESTED READING / TEXTS / REFERENCES

1. *D. P. Kothari and I. Nagrath, Electric machines: Tata McGraw-Hill Education, 2004.
2. *C.L. Wadhwa, Generation, Distribution and Utilisation of Electric Energy; (Wiley Eastern)
3. S. Chapman, Electric machinery fundamentals: Tata McGraw-Hill Education, 2005.
4. C.L. Wadhwa, Electric Power System; (Wiley Eastern)

EEA2020: Electrical Technology (for Mechanical Engineering Students)

Course Title	Electrical Technology
Course Number	EEA2020
Credits	3
Course Category	ESA
Pre-Requisite if any	EEA1110
Contact Hours	2-1-0 (Lecture-Tutorial-Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignment) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce power electronics devices and their applications. To introduce the basic concept of Induction motors, Synchronous motor, DC motors, transformer and special types of motors. To introduce the characteristics and speed control of these motors. To introduce tariff system and power factor improvement.
Course Outcome	At the end of the course the students will be able to: 1. Use different types of power semiconductor devices & power electronic converters for particular applications. 2. Know the working of DC motors, types of DC motors, characteristics, speed control techniques and their applications. 3. Know the working of Induction motors; understand the concept of rotor slip, its relationship to rotor frequency, equivalent circuit of an induction motor, speed control of induction motors and synchronous motors. 4. Know the working of special motors and transformers, to design tariff and to apply power factor improvement methods.

SYLLABUS	No. of Lectures
UNIT I: Principles of Power Electronics I-V and reverse recovery characteristics of Power diode; I-V characteristics of SCR and TRIAC, various operation modes of TRIAC; introduction to single phase rectifier, inverter & chopper and their applications.	12
UNIT II: DC Motors Construction, EMF and torque equation, types and characteristics, Speed Control and Starters, applications, Permanent magnet motors.	12
UNIT III: Three Phase Induction and Synchronous motors Three Phase Induction motors: Introduction, working principle, equivalent circuit and torque equation, torque slip characteristics, speed control, starters, and applications. Synchronous motors: Introduction, construction, Principle of operation, applications.	12
UNIT IV: Special Motors and Industrial Power Supply Special motors: Hysteresis motor, Reluctance motor, stepper Motor, Universal motor and their application. Industrial Power Supply: Autotransformers, wielding transformers, tariff system and power factor improvement	12
TOTAL:	**48**

SUGGESTED READING / TEXTS / REFERENCES

1. *G. K. Dubey, et al, Thyristorised Power Controllers; New Age International.
2. *D. P. Kothari and I. Nagrath, Electric machines: Tata McGraw-Hill Education, 2004.
3. S. Chapman, Electric machinery fundamentals: Tata McGraw-Hill Education, 2005.
4. M. S. Jamil Asghar, Power Electronics, PHI Learning

EEA2720: Electromagnetic Field Theory

Course Title	Electromagnetic Field Theory
Course Number	EEC2720
Credits	4
Course Category	DC
Prerequisite Courses	Applied Mathematics and Basic Physics
Contact Course	3-1-0 (Lecture-Tutorial-Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignment) (15%) Mid Semester Examination (1 Hour) (25%) End Semester Examination (2 Hour) (60%)
Course Objectives	To introduce the concepts of different coordinate systems, Maxwell's equations, static electric and magnetic fields and methods of solving for the quantities associated with these fields, time varying fields and displacement current, propagation of electromagnetic waves and their applications in practical problems.
Course Outcomes	After completing the course, the students should be able to: 1. Understand different orthogonal coordinate systems and their use; and, to describe static electric fields and associated energy in integral and point form in different media and on boundaries leading to notion of resistance and capacitance. 2. Describe static magnetic fields in integral and point form in different media and on boundaries, notion of inductance, time varying electric and magnetic fields, and, Maxwell's equations describing electromagnetic fields. 3. Understand the propagation of plane Electromagnetic waves and their power flow in different media employing Maxwell's equations, and to understand the transmission line as a specific application. 4. Apply various numerical methods for the estimation of electromagnetic field quantities.

SYLLABUS	**No. of Lectures**
UNIT-I: ELECTROSTATIC FIELDS Coordinate systems and their transformation; Electric Field Intensity; Gauss's Law and its application; Electric potential; Electric field in free space, conductors and dielectrics – Polarization; Boundary conditions; Poisson's and Laplace's equations; Capacitance; Energy density.	15
UNIT-II: MAGNETO STATICS AND TIME VARYING FIELDS Ampere's circuital law and its applications; Scalar and Vector magnetic potentials; Magnetic flux density – Magnetization; Boundary conditions, Lorentz-force equation, Force and torque; Inductance; Energy density; Faraday's Law; Transformer and motional EMF; Displacement current; Maxwell's equation in integral and point form.	11
UNIT-III: PROPAGATION OF ELECTROMAGNETIC WAVES Maxwell's equations in phasor form; Propagation of uniform plane waves in Free Space, Dielectrics and Conductors; Skin effect; Poynting's theorem and Power flow; Reflection of waves; Transmission lines.	11
UNIT-IV: APPLICATIONS OF ELECTROMAGNETIC WAVES AND NUMERICAL TECHNIQUES	9

Sources and effect of electromagnetic fields; Applications of Electromagnetic waves; Electromagnetic Interference and Compatibility; Numerical Methods for estimation of Electromagnetic field quantities.	
TOTAL:	**46**

SUGGESTED READING / TEXTS / REFERENCES

1. *W. H. Hayt & J.A Buck, "Engineering Electromagnetics," 7th Ed., McGraw Hill.
2. M. N. O. Sadiku, "Elements of Electromagnetics," Oxford University Press, 6th Ed., 2014.
3. Krous & Fleisch, "Electromagnetics with Applications", 5th Ed. McGraw Hill.
4. NPTEL lectures, (www. nptel.ac.in), Lecture series on Electromagnetic Fields, Dr. Harishankar Ramachandran, Department of Electrical Engineering, Indian Institute of Technology Madras MIT open Courseware, SWAYAM Portal.

EEC2110: Electrical Machines – I

Course Title	Electrical Machines – I
Course Number	EEC2110
Credits	4
Course Category	DC
Prerequisite Courses	None
Contact Course	3-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The Objective of this course is to build a firm foundation of Electrical Transformers and Induction Machines.
Course Outcomes	After successful completion of this course students will be able to: 1. Understand the working of different types of transformers and Induction machines. 2. Analyse the equivalent circuit of induction motor & transformers and evaluate their performances. 3. Understand various tests to be performed on transformers and induction machines to evaluate their performances. 4. Analyse the working of three phase transformer, auto transformer and parallel operation of transformers.

SYLLABUS	**No. of Lectures**
UNIT I: ELECTRICAL TRANSFORMER- I Principle of transformer action. Construction of two winding transformer. Equivalent circuits and phasor diagrams of Ideal and real transformers; Losses in transformers, Testing: open circuit, short circuit tests and Sumpner's test; per unit system, Efficiency and voltage regulation.	12
UNIT II: ELECTRICAL TRANSFORMER II Autotransformers: Introduction, Comparison with two winding transformers; Three phase transformer: Construction, phase groupings; Parallel operation; Phase transformation: Three-phase to two-phase, single-phase, and six-phase, Application of different types of transformer.	12
UNIT III: INDUCTION MACHINE Electro-mechanical energy conversion principles: Force and EMF production in a rotating machine; Classification of rotating machine; 3-phase induction machines: Types, construction; Introduction to windings and winding factor; Production of revolving magnetic field, working principle on 3-phase induction machine; equivalent circuit; phasor diagram; Losses and power flow diagram; slip-torque curves; no load and blocked rotor tests; starting methods.	12
UNIT IV: SELECTED TOPICS IN ELECTRICAL MACHINES Space harmonics, effects of space harmonics; cogging, crawling, and noise. Single-phase induction motors: Principle of operation; double revolving field and cross field theories; equivalent circuit and torque-speed characteristics; Starting methods of single-phase induction motors: split-phase and shaded pole motors. Induction generator and its applications.	12
TOTAL:	**48**

SUGGESTED READING / TEXTS / REFERENCES

1. *Stephen Umans , "Fitzgerald & Kingsley's Electric Machinery," 7th Edition, McGraw Hill Publications.
2. I. J. Nagrath and D. P. Kothari, "Electric Machines," Tata McGraw Hill, 2004.
3. Stephen J. Chapman , "Electric Machinery Fundamentals," 5th Edition, McGraw Hill.
4. P. S. Bhimra, "Electrical Machinery," 7th Edition, Khanna Publishers.
5. A. S. Langsdorf, "Theory of AC Machinery," 2nd edition, McGraw Hill Publications.
6. M. G. Say, "Alternating Current Machines," 4th edition, Pitman Publications.
7. S. Ghosh, "Electrical Machines", 2nd Edition, Peasrson.

EEC2120: Electrical Machines – II

Course Title	Electrical Machines – II
Course Number	EEC2120
Credits	4
Course Category	DC
Prerequisite Courses	None
Contact Course	3-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The Objective of this course is to enable the students to understand the basic concepts of Synchronous Machines, dc Machines and some special machines.
Course Outcomes	After successful completion of this course students will be able to: 1. Understand the construction and working of synchronous machine, dc machine and some special machines such as universal motor, permanent magnet dc machines, hysteresis motor, reluctance motor, and stepper motor 2. Evaluate the performance of synchronous machines and dc machines. 3. Understand various tests to be performed on synchronous machines and dc machines. 4. Understand the operation of synchronous machines connected to infinite bus-bar.

SYLLABUS	**No. of Lectures**
UNIT I: SYNCHRONOUS MACHINES- I Construction, armature reaction and two reaction theory, synchronous reactance and phasor diagram, expression for power developed and power angle curve for salient and non-salient pole machines, maximum power. Open circuit, short circuit and zero power factor tests, Slip test. Alternator load characteristics. Voltage regulation and its determination by synchronous impedance and Potier triangle methods.	12
UNIT I: SYNCHRONOUS MACHINES- II Synchronization of three phase alternators, effect of governor characteristics on load sharing of alternators, operation on infinite bus bars, active and reactive power control. Synchronous motors: methods of starting, synchronizing power, hunting, V-curves, synchronous condenser, Transient and sub-transient reactances and time constants, Negative and zero sequence impedances.	12
UNIT III: DC MACHINES Construction, function of commutator, simplex lap and wave windings, emf and torque equations, armature reaction and commutation. D. C. generator characteristics.	12
UNIT IV: DC MACHINES AND SPECIAL MACHINES Characteristics of dc motors, testing of dc machines, Hopkinsons test and Swinburne test, dc motor starters, Special motors: universal motor, permanent magnet dc machines, hysteresis motor, reluctance motor, and stepper motor.	12
TOTAL:	**48**

SUGGESTED READING / TEXTS / REFERENCES

1. *I. J. Nagrath and D.P.Kothari, Electric Machines, Tata McGraw Hill, 2004.
2. Stephen J. Chapman , "Electric Machinery Fundamentals," 5th Edition, McGraw Hill.
3. B. S. Guru and H. R. Hiziroglu, Electric Machinery and Transformers, 3 Ed., Oxford University Press (Indian Edition).
4. P. S. Bhimra, "Electrical Machinery," 7th Edition, Khanna Publishing House
5. E. Openshaw Taylor, "Performance and Design of A. C. Commutator Motors", A. H. Wheeler, New Delhi, 1971.
6. S. Ghosh, "Electrical Machines", 2nd Edition, Pearson.

EEC2310: Power System Engineering

Course Title	Power System Engineering
Course Number	EEC2310
Credits	4
Course Category	DC
Prerequisite Courses	None
Contact Course	3-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The goal of the course is to deal in the design and performance analysis of power transmission lines. Application cases will be discussed during the lectures and will be further illustrated during the tutorials with real examples.
Course Outcomes	After successful completion of this course students will be able to: 1. Select the types of overhead line conductors and also to evaluate the line parameters of overhead transmission lines. 2. Design and Model the transmission line and evaluate its performance. 3. Know different types of insulators and mechanical design of overhead transmission lines. 4. Know construction details and evaluate their electrical parameters of insulated cables. 5. Design different types of electrical power distribution systems.

SYLLABUS	**No. of Lectures**
UNIT I: ELECTRICAL CHARACTERISTICS OF O.H. LINES Types of conductors for O.H. power transmission lines. Calculation of Line parameters: resistance, inductance and capacitance for single and double circuit lines; bundle conductors. Concept of GMD and GMR. Effect of earth on line capacitance.	12
UNIT II: PERFORMANCE OF O.H. TRANSMISSION LINES: Representation of short, medium and long transmission lines: nominal-T, nominal-π and equivalent-π. Characteristic impedance (Z_0) and SIL, ABCD parameters, Voltage regulation and efficiency. Series and shunt compensation of line. Corona and radio interference.	12
UNIT III: INSULATORS AND MECHANICAL DESIGN OF O.H. LINES Types of insulators: pin, disc and strain type. Voltage distribution and equalization; Arcing horns, Types of line supports, Air clearance. Sag calculations: effect of wind and ice loading, ground clearance. Vibration of conductors and dampers.	12
UNIT IV: UNDERGROUND CABLES AND DISTRIBUTION SYSTEMS Construction of single core and three core cables, electrostatic stresses and grading of cables, thermal rating of cables, causes of cable failure. Different types of distribution systems. Distributors fed from one end and both ends, ring mains, unbalanced loading.	12
TOTAL:	**48**

SUGGESTED READING / TEXTS / REFERENCES

1. *Nagrath and Kothari, “Power System Engg.,” 3rd edition, TMH.
2. C. L. Wadhwa, “Electrical Power Systems,” Wiley Eastern.
3. Cotton and Barbar, “Transmission and Distribution of Electrical Energy,” BI Publications.
4. Ashfaq Husain, “Electrical Power System,” 4th edition, CBS.
5. B.R. Gupta, “Power System Analysis and Design,” S. Chand.

EEC2510: Electrical Measurements

Course Title	Electrical Measurements
Course Number	EEC2510
Credits	4
Course Category	DC
Prerequisite Courses	None
Contact Course	3-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce the concepts of measurement standards, measurement errors, operation of electrical and electronic measuring instruments their testing and calibration, measurement of electrical quantities and circuit parameters.
Course Outcomes	After successful completion of this course students will be able to: 1. Analyse measurement errors and use AC and DC bridges for relevant parameter measurements 2. Develop an understanding of construction and working of different measuring instruments 3. Suggest the kind of instruments and design instrumentation schemes suitable for magnetic measurements 4. Utilize instruments to measure frequency and phase. Test and troubleshoot electronic circuits using various measuring instruments

SYLLABUS	No. of Lectures
UNIT I: BASICS OF MEASUREMENT: **S**tandards, errors of measurement systems and their analysis, characteristics of instruments & measurement system**.**, Bridges for measurement of Resistances Inductance and Capacitance Principle of AC potentiometers, Bridges for measurement of Resistances Inductance and Capacitance.	12
UNIT II: ELECTROMECHANICAL INSTRUMENTS: Galvanometers, Dynamic behaviour of D' Arsonval Galvanometer. Permanent magnet moving coil, Moving iron, Electrodynamometer, Thermal, and Electrostatic instruments, their errors and remedies. Concept of multi range instruments. Measurement of power in three phase systems. Single phase Induction type Energy meter. Testing of Wattmeter and Energy Meter using phantom method of loading.	12
UNIT III: INSTRUMENT TRANSFORMERS AND MAGNETIC MEASUREMENTS: Principle, construction and testing of Current Transformer and Potential Transformer and their errors, determination of B-H curve of magnetic specimen. Measurement of Iron losses and their separation using Lloyd Fisher Square. Synchro-scope, Harmonic analysis of waveforms	12
UNIT IV: ELECTRONIC INSTRUMENTS: Average reading, RMS reading and True RMS reading voltmeters. Electronic potentiometer, Instrumentation Amplifier. Review of basic CRO circuit, Probes, Oscilloscope control. Measurement of voltage, frequency, and phase using a CRO. Multimeter.	12
TOTAL:	**48**

SUGGESTED READING / TEXTS / REFERENCES

1. *Golding & Widis Electrical Measurement & Measuring Instruments, Pitman
2. *H. S. Kalsi Electronic Instrumentation, TMH
3. A. K. Sawhney Electric & Electronic Measurement & Instrumentation, Dhanpat Rai
4. David Bell Electronic Instrumentation & Measurement, PHI
5. NPTEL lecture notes.

EEC2710: Circuit Theory

Course Title	Circuit Theory
Course Number	EEC2710
Credits	4
Course Category	DC
Prerequisite Courses	None
Contact Course	3-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The aim of this course is to make the students competent in analysing electrical circuits and to apply techniques to solve circuit problems using basic circuit theorems and other structured methods.
Course Outcomes	After successful completion of this course students will be able to: 1. Analyse network problems using various AC/DC theorems and to determine the transient response of RLC circuits to various inputs. 2. Determine parameters of various two port power or communication networks. 3. Determine Driving point and Transfer functions of various networks, to anlayze the time domain response using Pole-Zero Plot, Design basic type of electric filters. 4. Formulate multi-bus power network equations using Graph Theory and formulate state space equations representing a system.

SYLLABUS	**No. of Lectures**
Unit I: Transient Response and Network Theorems Review of basic circuit terminology (Lump and Distributed Parameters, Active and Passive elements, Dependent and Independent Sources), Transient response of simple RL, RC and RLC circuits to step input and sinusoidal input, Maximum Power transfer theorem; Reciprocity theorem, Millman's and Tellegen's theorems.	12
Unit II: Two Port Networks Open circuit, short circuit, hybrid and transmission (ABCD) parameters of two-port network, relationship between different two-port network parameters, Interconnection of two-port networks, ABCD parameters in terms of OC & SC parameters, Modelling of Transistor using hybrid parameters.	12
Unit III: Network Functions and Electric Filters Introduction to Network functions, Natural and Complex frequencies, Driving point and Transfer functions, Poles and Zeros of network function, physical interpretation of poles and zeros, time domain response from pole-zero plot. Use of electric filters, Constant K Type Low pass and high pass passive filters. Disadvantages of Passive filters, Introduction to active filters.	12
Unit IV: Graph Theory and State Variable Analysis Definition of various terms used in graph theory, Formulation of various network matrices and relationship between them, Formulation of network equations on the basis of loop, mesh, tree branch voltage and node-pair voltage Sate space representation of simple RLC circuits, formulation of state equations, Solution of state equations.	12
TOTAL:	**48**

SUGGESTED READING / TEXTS / REFERENCES

1. ***Choudhry D. Roy, "Network and Systems", New Age International, 2003.
2. Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw-Hill Publishing Company Ltd, 2008. **(Unit 1**)
3. Kuo F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India, 2008.
4. Ashfaq Husain, "Networks and Systems", Khanna Publishers, 2nd Ed., Delhi.
5. Charles Alexander and Matthew Sadiku, "Fundamentals of Electric circuits", McGraw Hill Publications 2013. (**Unit 2, Unit 4).**
6. Shankar and Shyam Mohan, "Circuits and Network Analysis and Synthesis", Tata Mc Graw Hill, New Delhi, 2006. **(Unit 3)**
7. NPTEL lectures, (**www. nptel.ac.in**), Lecture series on Networks, Signals and Systems by Prof. T.K. Basu, Dept. Of Electrical Engineering, I.I.T.,Kharagpur, MIT open Courseware, SWAYAM Portal.

EEC2210: Power Electronics–I

Course Title	Power Electronics–I
Course Number	EEC2210
Credits	4
Course Category	DC
Prerequisite Courses	Nil
Contact Course	3-1-0
Type of Course	Theory
Course Assessment	Course Work (Home Assignment) (15%) Mid Semester Examination (1 Hour) (25%) End Semester Examination (2 Hour) (60%)
Course Objectives	To introduce the concepts of Power Electronic Devices, different types of converters, triggering circuits and their control schemes, fourier analysis of power electronic converters.
Course Outcomes	At the end of the course the students will be able to: 1. Analyze the characteristics of various power electronic devices 2. Apply various converter control strategies and design various power electronic triggering and commutation circuits. 3. Analyze different single phase ac-dc converters with different types of loads and evaluate their performance. 4. Analyze different three phase ac-dc converters and dual converters with different types of loads and evaluate their performance.

SYLLABUS	**No. of Lectures**
UNIT I: Power Electronic Devices Introduction to power electronics and its applications. Ideal and practical switches, losses in practical switches. Static Characteristics of semiconductor power devices: Diode, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and recent devices. di/dt and dv/dt limitations and their protection, snubber circuits.	12
UNIT II: Triggering and Commutation Circuits Switching Characteristics of SCR and its methods of turn on and turn off. Gate characteristics. Basic triggering circuits (R, RC, UJT etc). Driver and isolation circuits. IC based triggering circuits. Switching angle control schemes: cosine, ramp and digital schemes. Working of Commutation circuits: Modified Mc-Murray circuit, self-commutation, auxiliary pulse commutation and complementary commutation.	12
UNIT III: Single phase ac-dc controlled converters Half-wave and full-wave controlled rectifiers: Mid-point and bridge configurations. Analysis for R, RL and RLE loads. Effect of free-wheeling diode. Semi-converters. Performance parameters: Output voltage, harmonics, power factor, ripple factor, form factor, ripple factor, THD, distortion factor.	12
UNIT IV: Three phase ac-dc converters and Dual Converters Three-phase half-wave rectifier. Fully-controlled 3-phase rectifier with R and RL load. 3-phase semi-converter. Twelve-pulse converter. Circulating and non-circulating current configurations of dual converters. Introduction to cyclo-converter.	12
TOTAL:	**48**

SUGGESTED READING / TEXTS / REFERENCES

1. *A. Joshi, G. K. Dubey, R. M. K. Sinha, S. R. Doradla, "Thyristorised Power Controllers," 2nd Edition, New Age International.
2. *M.H. Rashid, "Power Electronics," 4th Ed., PHI Learning, New Delhi.
3. P. S. Bhimra, "Power Electronics,", Khanna Publishing House, 2012.
4. V. R. Moorthy, "Power Electronics," Oxford University 2007 Press.
5. M. S. Jamil Asghar, "Power Electronics," PHI Learning, 2014.

Annexure-III of special BOS held on 24.05.2019
B.Tech./B.E. 3rd year syllabi w.e.f. session 2019-20

Note: Revised syllabi of B.E. will be same as that of B.Tech. except that an extra 'E' is added in the beginning of the course codes.

Revised syllabi of B.Tech. 3rd year w.e.f. session 2019-20

Course Title	**Automation & Control Engineering**
Course Number	EEA3010
Credits	4
Course Category	ESA
Prerequisite Courses	None
Contact Course	3-1-0 (Lecture-Tutorial- Practical)
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To focus on general concept of control systems incorporating modelling and performance analysis with potential application to engineering systems. Modelling in time and frequency domains stability analysis.
Course Outcomes	After successful completion of the course students will be able to: 5. Acquire general understanding of control systems, including system modelling and its performance analysis. 6. Develop mathematical models of a simple mechanical and electrical system. 7. Design proper controller for a control system to achieve desired specifications. 8. Apply the State Space representation. Design and analyse state space model using MATLAB.

SYLLABUS	**No. of Lectures**
UNIT I: INTRODUCTION TO CONTROL SYSTEMS ENGINEERING AND MATHEMATICAL MODELLING Review of Control System Engineering, effects of feedback, modelling, and transfer function of mechanical, electrical and hydraulic systems, DC and AC servomotors, Tacho-generators, Synchro error detector.	12
UNIT II: BLOCK DIAGRAM, SIGNAL FLOW GRAPHS & STATE VARIABLE TECHNIQUES Block diagram representation & reduction techniques, signal flow graphs, Mason's Gain Formula, System representation in various forms of state variables, concept of controllability and observability.	12
UNIT III: TIME DOMAIN ANALYSIS OF LINEAR SYSTEMS Transient and Steady state responses, transient response of second order systems, error constants, Routh-Hurwitz criterion, root-locus technique and its applications. Concept of proportional, derivative, integral and PID Controllers.	12
UNIT IV: FREQUENCY DOMAIN ANALYSIS Stability of Control Systems, Frequency domain analysis of linear systems using Bode's plot, gain margin and phase margin. Nyquist criterion and its application. Correlation between Time and Frequency response	12
TOTAL:	**48**

Books*/ References	**References** 1 *B.C.Kuo Automatic Control Systems, Prentice Hall of India, 2002. 2 *Norman S. Nise Control Systems Engineering, Wiley Eastern, 2007. 3 K. Ogata, Modern Control Engineering, Prentice Hall of India, 2003. 4 Nagrath and Gopal, Control System Engineering, New Age, 2007. 5 Samarjit Ghosh, Control systems, Pearson. 6 <u>Nagrath and Gopal Control System TMH, 2002.</u> 7 <u>B.S.Manke, Linear Control Systems, Khanna.</u> 8 NPTEL lectures/notes and MIT open courseware.

	9 Relevant Journals/ Magazines / IEEE Transactions on Automatic control.		
Course Assessment/ Evaluation/ Grading Policy	**Sessional**	**Assignments / Quiz / Presentations (2 to 3)**	15 Marks
		Mid Term Examination (1 Hour)	25 Marks
		Sessional Total:	**40 Marks**
	End Semester Examination (2 Hours)		60 Marks
	Total		**100 Marks**

COs- POs MAPPING

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x		x							
CO 2	x	x		x					x		
CO 3	x	x							x	x	
CO 4						x			x		

Course Title	**Electrical Drives**
Course number	**EEC3110**
Credit Value	**4**
Course Category	**DC**
Pre-requisite	EEC2120, EEC3210
Contact Hours (L-T-P)	**3-1-0**
Type of Course	Theory
Course Objectives	To introduce the basic concepts of dc electric drives and ac electric drives.
Course Outcomes	At the end of the course the students will be able to 1. Apply the knowledge of drives and use them effectively. 2. Suggest the particular type of AC/DC drive system for an application.
Syllabus	**UNIT I: Fundamentals of Electric Drives** Introduction and classification of electric drives, comparison with other types of drives. Characteristics of different types of mechanical loads, stability of motor-load systems, multi-quadrant operation. Drive parameters for rotational and translational motion: Equivalent torque and moment of inertia. Fluctuating loads and load equalization. Thermal loading of motors, estimation of motor rating for continuous, intermittent and short-time duty loads. **UNIT II: DC Drives** Characteristics of dc motors and PM dc motor. Conventional methods of speed control: rheostatic, field and armature control. Electric braking of dc drives: Regenerative braking, plugging and Dynamic braking. Converter controlled dc drives: continuous and discontinuous conduction modes of operation. Chopper controlled drives. Comparison of phase and chopper controlled drives. **UNIT III: A.C. Drives I** Review of three phase induction motor characteristics. Electric braking of induction motor drives: Regenerative, Plugging, ac and dc dynamic braking. Methods of speed control of induction motors: stator voltage control, variable frequency control, and pole changing and pole amplitude modulation, rotor resistance control. **UNIT IV: A.C. Drives II** Static rotor resistance control of induction motor. Slip power recovery schemes: static Scherbius and Kramer drives. Voltage source inverter (VSI) controlled induction motor drive, current regulated VSI drives. Synchronous motor variable frequency drive.

Books*/References	1. G. K. Dubey*, "Fundamentals of Electric Drives", second edition, Narosa Pub. House, New Delhi. 2. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall. 3. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall of India.

POs	a	b	c	d	e	f	g	h	i	j	k
CO1	x			x		x				x	x
CO2	x	x		x	x	x	x			x	x
CO3	x			x		x				x	x
CO4	x	x		x	x	x	x			x	x

Course Title	**Power System Analysis**	
Course Number	EEC3310	
Credits	4	
Course Category	DC	
Prerequisite Courses	Power System Engineering	
Contact Course	3-1-0 (Lecture-General- Practical)	
Type of Course	Theory	
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)	
Course Objectives	To introduce the concepts of Load flow analysis, bus admittance matrix, load flow problem formulation and solution techniques, economic load dispatch, load frequency and voltage control, fault analysis, and steady state and transient stability analysis.	
Course Outcomes	After successful completion of this course, students will be able to: 1. Develop power system network models and solve load flow problems using various techniques. 2. Formulate economic load dispatch problems. 3. Analyse various faults and calculate the associated fault values for symmetrical and unsymmetrical faults. 4. Perform stability analysis of a simple power system for small and large disturbances.	
SYLLABUS		**L+G**
UNIT I Load Flow Analysis: Per unit system of calculation, Formation of Bus admittance matrix, Formulation of load flow problem; type of buses, Solution techniques – Gauss-Seidel and Newton–Raphson. Representation of voltage-controlled buses and transformers. Decoupled and fast-decoupled load flow.		**12**
UNIT II Economic Operation of Power Systems: Study of economic dispatch problem in a thermal power station, consideration of transmission losses in economic dispatch, simplified method of loss-formula calculation, solution of coordination equation, unit commitment, Introduction to load frequency and voltage control.		**12**
UNIT III Fault Analysis: Types of fault, calculation of fault current and voltages for symmetrical short circuit. Symmetrical components, Sequence impedance and networks of power system elements, unsymmetrical short circuits and series fault.		**12**
UNIT IV Stability Analysis: Introduction to steady state and transient stability of power systems, swing equation, equal area criteria, solution of swing equation, methods of improving stability, Introduction to voltage stability.		**12**
Total (L+G)		**48**
SUGGESTED READING / TEXTS / REFERENCES		

*Nagrath and Kothari, Power System Analysis, 4th edition (TMH). B.R. Gupta, Power System Analysis and Design. Grainger and Stevenson, Power System Analysis (TMH). Hadi Saadat, Power System Analysis, (TMH).		

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x			x		x				x	x
CO 2	x			x		x				x	x
CO 3	x			x		x	x			x	x
CO 4	x	x		x	x	x				x	x

Course Title	**Electrical Power Generation and Utilization**		
Course number	**EEC3320**		
Credit Value	**4**		
Course Category	**DC**		
Pre-requisite	**Nil**		
Contact Hours (L-G-P)	**3-1-0**		
Type of Course	Theory		
Course Objectives	To introduce the fundamentals of illumination engineering, various types of batteries and their field of applications, railway electrification, various types of services and their characteristics, various types of conventional power plants and their suitability criterion, site selection, maintenance and operation.		
Course Outcomes	At the end of the course the students will be able to 1. Have the knowledge of thermal and nuclear power plants and their working. 2. Have the knowledge of hydro and gas power plants and their working. 3. Have the knowledge of various types of cogeneration, captive power plants and various aspects of illumination design. 4. Understand different types of electric traction system, different services and maintenance of line.		
Syllabus	**Unit**	**Topic**	**L+G**
	Unit I	**Thermal Power Plants:** Coal fired Plants: Site selection, various components, parts and their operation, Steam and fuel cycles, Pollution control, Modern clean coal Technologies. Nuclear Power Plants: Site Selection, Principal of Fission, Main components of nuclear reactor, Fast Breeder and other reactors, Fuel extraction, enrichment and fabrication, Basic control of reactors, Environmental aspects.	12
	Unit II	**Hydro and Gas Power Plants:** *Hydro Plants*: Site selection, Classification of Hydro plants, Main components and their functions, Classification of turbines, Pumped storage plants, Environmental aspects. *Gas Turbine plants*: Principle of operation, Open & closed cycle plants, Combined cycle plants, IGCC.	12
	Unit III	**Cogeneration, Captive Power Plants and illumination:** Cogeneration Plants, Cogeneration Technologies, Types of CPP, Concept of Distributed Generation. *Illumination:* Laws of illuminations, Various aspects of illumination design. *Electrolytic Effects:* Types of Batteries, their components, Charging & maintenance.	12
	Unit IV	**Electric Traction:** Speed time curves, Tractive efforts and specific energy consumptions, Track electrification & traction substations, Current collectors, Negative boosters and control of traction motors.	12

		Total L+G	**48**
Books*/ References	1. *B.R.Gupta, Generation of Electrical Energy (Eurasia Pub. House). 2. M.V.Deshpande, Elements of Electrical Power Station Design (Wheeler Pub. House). 3. *H.Pratab, Art & Science of Utilization of Electrical Energy (Dhanpat Rai & sons).		
Course Assessment/ Evaluation/ Grading Policy	**Sessional**	**Assignments**	15 Marks
		Mid Term Examination (1 Hour)	25 Marks
		Sessional Total	**40 Marks**
	End Semester Examination (2 Hours)		60 Marks
		Total	**100 Marks**

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x			x		x				x	
CO 2	x			x		x				x	
CO 3	x	x		x	x	x	x			x	x
CO 4	x	x		x	x	x				x	

Course Title	**Dynamic system analysis**	
Course number	**EEC3410**	
Credit Value	**4**	
Course Category	**DC**	
Pre-requisite	**Signals and systems**	
Contact Hours (L-T-P)	**3-1-0 (L-T-G)**	
Type of Course	**Theory**	
Course Objectives	The objective of the course is to introduce the concepts in the analysis and design of control systems. To focus on general concept of control systems incorporating modelling and performance analysis with potential application to engineering systems.	
Course Outcomes	At the end of the course the students will be able to 1. Understand the basics of Automatic Control System including system modelling and its performance analysis 2. Apply the State Space representation and use it for the stability analysis of the dynamic systems. Design system model using MATLAB. 3. Analyze the system using Bode Plot and Root Locus techniques and suggest the relative stabilities of different dynamic systems 4. Design and compare different types of controllers and apply control systems theory to a real engineering system.	
Syllabus		**Lecture**
	Control Concepts and Mathematical Modelling: System concepts, Effect of Feedback, System Modelling, Transfer Function, and Modelling of mechanical, electrical, and hydraulic systems. Analogy between the elements of different types of systems. State Variable Representation. Relationship between State Model and Transfer Function.	12
	System Representation and Control Components: Block Diagram Algebra. Signal Flow Graph and Mason's Gain Formula. Numerical simulation using MATLAB and Simulink for linear time invariant systems. Applications of Synchro, Tachogenerator, Servomotor and Stepper motor in control systems.	12
	Time Response Analysis: Time response of First Order and Second Order systems. Steady State Error and Error Coefficients. State Transition Matrix and solution of State Equations. Concepts of Stability –Routh-Hurwitz criterion of Stability. Root Locus technique. Introduction to P, PI and PID controllers.	12

	Frequency Response Analysis and Control System Design: Frequency response of second order system. Bode Plots, Polar Plots, Nyquist stability criterion, Gain margin and phase margin. Correlation between Time and Frequency response. Cascade and feedback compensation – design of lag, lead, lag-lead compensators.	12
	Total No. of Lectures	**48**
Books*/ References	**References** 1 *B.C.Kuo Automatic Control Systems, Prentice Hall of India, 2002. 2 *Norman S. Nise Control Systems Engineering, Wiley Eastern, 2007 3 K. Ogata, Modern Control Engineering, Prentice Hall of India, 2003. 4 Nagrath and Gopal, Control System Engineering, New Age, 2007 5 Samarjit Ghosh, Control systems, Pearson 6 Nagrath and Gopal Control System TMH, 2002. 7 B.S.Manke, Linear Control Systems, Khanna 8 NPTEL lectures/notes and MIT open courseware. 9 Relevant Journals/ Magazines / IEEE Transactions on Automatic control.	

Course Assessment/ Evaluation/ Grading Policy	**Sessional**	**Assignments / Quiz / Presentations (2 to 3)**	15 Marks
		Mid Term Examination (1 Hour)	25 Marks
		Sessional Total:	**40 Marks**
		End Semester Examination (2 Hours)	60 Marks
		Total	**100 Marks**

COs- POs MAPPING

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x		x							x
CO 2	x	x		x		x			x		x
CO 3	x	x									x
CO 4									x	x	x

Course Title	**Electrical and Electronic Instrumentation**
Course number	**EEC3510**
Credit Value	**3**
Course Category	**DC**
Pre-requisite	**Basic Electrical and Electronics Engineering**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	Theory
Course Objectives	To introduce the concepts of digital measurement, data management, transducers and their applications in the measurement of physical quantities and understanding of latest instrumentation and measurement technologies.
Course Outcomes	At the end of the course the students will be able to: 1. Understand different methods of digital instrumentation, data transmission and acquisition. 2. Select electrical transducers according to specific applications and requirements. 3. Analyse different methodologies for the measurement of various physical quantities (pressure, temperature, flow etc). 4. Relate new instrumentation technologies and recent developments in (Wide Area Measurement Systems, Global Positioning System, Nano Instrumentation, MEMS, and Smart Sensors etc).

Syllabus	**Topic**	**Lecture**
	Unit I - Digital Instruments and Measurement	
	Comparative Analysis of Digital Instruments and Analog Instruments	12
	Digital Voltmeter,	
	Digital Multimeter	

	Digital Measurement of Frequency	
	Digital Measurement of Time	
	Digital Measurement of Energy	
	Home Assignment/ Tutorial	
	Unit II - Data Transmission and Acquisition	
	Amplitude and Frequency Modulation	12
	Time Division and Frequency Division Multiplexing	
	Telemetry Principles and Applications	
	Analog and Digital Data Acquisition Systems	
	Data Logger	
	Digital Storage Oscilloscope	
	Home Assignment/ Tutorial	
	Unit III – Transducer	
	Introduction, Classification of transducer	12
	Characteristics of transducer	
	Transducer for various physical quantity measurement.	
	Digital Transducers.	
	Home Assignment/ Tutorial	
	Unit IV - Recent Development	
	Intelligent Instrumentation	12
	Introduction to Virtual Instrumentation	
	MEMS based Sensors, Smart Sensors and GPS	
	Wide Area Measurement and Nano Instrumentation	
	Home Assignment/ Tutorial	
	Total No. of Lectures	**48**
Books*/ References	1. *D.V.S Murty, "Transducers and Instrumentation", PHI. 2. *T. S. Rathore, "Digital Measurement Techniques", Narosa Publishing House. 3. Morris, "Principle of Measurement and Instrumentation", PHI 4. H. K. P Neubert, "Instrument Transducers", Oxford University Press. 5. Rangan Mani and Sarma, "Electrical Instrumentation", TMH 6. Relevant journals/ Magazines / IEEE Transaction papers.	

Course Assessment/ Evaluation/ Grading Policy	**Sessional**	**Assignments / Quiz / Presentations (3 to 4)**	15 Marks
		Mid Term Examination (1 Hour)	25 Marks
		Sessional Total	**40 Marks**
	End Semester Examination (2 Hours)		60 Marks
		Total	**100 Marks**

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	**x**	**x**									**x**
CO 2		**x**	**x**								**x**
CO 3	**x**				**x**					**x**	**x**
CO 4	**x**		**x**							**x**	

Course Title	**High Voltage Engineering**
Course Number	EEC3610
Credit Value	3
Course Category	Core

Pre-requisite	-
Contact Hours (L-T-P)	2-1-0
Type of course	Theory
Course Objectives	To introduce the basic concepts of high voltage engineering including mechanism of electrical breakdown in gases, liquids and solids, high voltage ac/dc and impulse generation and measurement.
Course Outcomes	At the end of the course the students will be able to: 1. learn the fundamental concept of electric breakdown in liquids, gases, and solids. 2. understand fundamental concepts of high voltage AC, DC, and impulse generation. 3. learn the techniques employed in high voltage measurements.

Syllabus	**TOPICS**	**Lectures**
	UNIT I: Breakdown Mechanisms in Dielectrics: Breakdown Mechanisms in Gases: Townsend's theory, Streamer theory, Breakdown in electronegative gases: Paschen's Law. Breakdown Mechanisms in Liquids – Suspended Particle mechanism, Cavitation & Bubble mechanism, Stressed Liquid Volume mechanism. Breakdown Mechanisms in Solids: Intrinsic breakdown, Streamer breakdown, Electromechanical breakdown, Thermal breakdown, Electrochemical breakdown, Tracking & Treeing. Assignment/Quiz/Presentation/Tutorial	**12**
	UNIT II: Generation of High Voltages: Generation of Alternating Voltages: Testing transformers, Resonant transformers, Generation of high frequency voltages, Generation of DC Voltages: Simple rectifier circuits, Cascaded circuits, Cockcroft-Walton circuit, Electrostatic generators, Van-de-Graff generator, Generation of Impulse Voltages: Single stage and multistage impulse generator circuits, Marx generator. Assignment / Quiz / Presentation / Tutorial	**12**
	UNIT III: Measurement of High Voltages: High Voltage Measurement techniques, Peak Voltage Measurement by spark gaps- Sphere gaps, Uniform field electrode gaps, rod gaps Generating voltmeters, Electrostatic voltmeters, Chubb-Fortescue Method, Potential dividers, Impulse voltage measurements., Assignment/Quiz/Presentation/Tutorial	**12**
	Total No. of Lectures	**36**
Books*/References	1. E. Kuffel, W.S. Zaengl, and J. Kuffel High Voltage Engineering Fundamentals, Elsevier India Pvt. Ltd, 2005. 2. M.S. Naidu and V. Kamaraju, High Voltage Engineering, Tata McGraw-Hill Publishing Company Ltd., New Delhi.	

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x			x		x					
CO 2	x			x		x					
CO 3	x	x		x	x	x	x				

Course Title	**Microcontroller Systems and Appl.**
Course number	**EEC-3710**
Credit Value	**4**
Course Category	**DC**
Pre-requisite	**ELA2010**
Contact Hours (L-T-P)	**3-1-0**

<table>
<tr><td colspan="2">Type of Course</td><td colspan="3">Theory</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The Course objective is to impart a comprehensive working knowledge of 8051 microcontroller regarding its architecture, coding, I/O ports, Timer, Interrupts, A-D, D-A conversion, serial and parallel communication along with an introduction to a high end 32 bit TM4C123G</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">After successful completion of this course students will be able to demonstrate

1. an in-depth knowledge of a 8051 microcontroller and do basic programming.
2. an ability to program in assembly, C language for peripherals and other applications
3. basic working knowledge of TM4C123G along with some basic programming skills
4. an ability to interface microprocessor with other devices and develop simple projects</td></tr>
<tr><td rowspan="25">Syllabus</td><td>Module</td><td colspan="2">Topic</td><td>Lecture</td></tr>
<tr><td rowspan="6">Unit-I</td><td colspan="3">Introduction to Microcontroller and I/O Port programming</td></tr>
<tr><td colspan="2">Introduction: The 8051 Microcontroller, Criteria for choosing a microcontroller, 8051 family members and block diagram, Pin description</td><td>02</td></tr>
<tr><td colspan="2">Assembly Language Programming: Program Counter and ROM space, data types and directives, PSW, Register Banks and stack, Addressing Modes</td><td>03</td></tr>
<tr><td colspan="2">I/O Port Programming: I/O Ports, Bit addressability & Read Modify-write feature</td><td>02</td></tr>
<tr><td colspan="2">Instruction set and programming: Arithmetic, Logic, Single bit, Jump, Loop and Call Instructions and programming in C</td><td>03</td></tr>
<tr><td colspan="2">Assignment/ Quiz/ Presentation</td><td>02</td></tr>
<tr><td rowspan="6">Unit-II</td><td colspan="3">8051 Timer/counter/Interrupt and serial communication Programming</td></tr>
<tr><td colspan="2">Timers and Counters: Timer Registers, TMOD Register, Timer mode 1, mode 2, mode 3 programming, Counter Programming</td><td>03</td></tr>
<tr><td colspan="2">Interrupts: 8051 interrupts, IVT for 8051, IE register, TCON register and Timer Interrupts, External H/W Interrupts</td><td>03</td></tr>
<tr><td colspan="2">Interrupt Programming: Serial Port Interrupts Programming, interrupt priority upon reset and IP register.</td><td>03</td></tr>
<tr><td colspan="2">Serial communication and Programming: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051 C</td><td>02</td></tr>
<tr><td colspan="2">Assignment/ Quiz/ Presentation</td><td>02</td></tr>
<tr><td rowspan="6">Unit-III</td><td colspan="3">High end Microcontroller</td></tr>
<tr><td colspan="2">Introduction: Introduction to TM4C123G, ARM architecture and execution; Simple addressing modes; Registers</td><td>01</td></tr>
<tr><td colspan="2">Programming basics: Assembly syntax; Functions; Logic operations; Parallel I/O, Switch and LED interfacing; IO synchronization</td><td>03</td></tr>
<tr><td colspan="2">Peripherals: Timers, Interrupt concept, Periodic interrupt, Edge-triggered interrupt, D/A conversion – Digital to analog conversion (DAC); A/D conversion – Analog to digital conversion (ADC)</td><td>03</td></tr>
<tr><td colspan="2">Communication: Serial I/O – Universal asynchronous receiver transmitter (UART); Serial I/O – SSI vs. UART vs. USB vs. I2C</td><td>02</td></tr>
<tr><td colspan="2">Assignment/ Quiz/ Presentation</td><td>02</td></tr>
<tr><td rowspan="6">Unit-IV</td><td colspan="3">Application</td></tr>
<tr><td colspan="2">Interfacing: LCD interfacing, Keyboard interfacing</td><td>02</td></tr>
<tr><td colspan="2">ADC, DAC and sensor interfacing: ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning.</td><td>02</td></tr>
<tr><td colspan="2">Motor control: Relay, PWM, DC and stepper motor: Relays and opto isolators, stepper motor interfacing, DC motor interfacing and PWM.</td><td>03</td></tr>
<tr><td colspan="2">IDE and CCS based coding and simulation of TM4C123G for real world problem, Introduction to Viva evaluation board</td><td>03</td></tr>
<tr><td colspan="2">Assignment/ Quiz/ Presentation</td><td>02</td></tr>
</table>

	Total No. of Lectures		**48**
Books*/ References	1. *Mazidi & Mazidi, "The 8051 Microcontroller and Embedded system", PHI publications, 2nd Ed 2. Manish K. Patel, "The 8051 Microcontroller based Embedded System", Mc Graw Hill, 3. *Mazidi & Naimi Arm, "Ti Tiva Arm Programming for Embedded Systems: Programming Arm Cortex-M4 Tm4c123g with C", Volume 2, 1st Ed, MicroDigitalEd, 2017 4. Tiva TM4C123GH6PM Microcontroller Data Sheet. 5. Getting Started with the Tiva TM4C123G LaunchPad Workshop Student Guide and Lab Manual (Chapter 4) 6. TivaWare Peripheral Driver Library User's Guide (iLearn-> Reference Materials -> SWTM4C-DRL-UG-2.1.0.12573.pdf) 7. Tiva C Series TM4C123G LaunchPad Evaluation Board User's Guide. 8. Cortex-M4 Technical Reference Manual. 9. Cortex-M4 Devices Generic User Guide. 10. Cortex-M3/M4F Instruction Set Technical User's Manual. 11. Jonathan W. Valvano, "Introduction to ARM Cortex-M Microcontrollers (fifth edition)," 2014.		
Course Assessment/ Evaluation/ Grading Policy	**Sessional**	**Assignments / Quiz / Presentations (3 to 4)**	15 Marks
		Mid Term Examination (1 Hour)	25 Marks
		Sessional Total	**40 Marks**
	End Semester Examination (2 Hours)		60 Marks
		Total	**100 Marks**

CO-PO Mapping

Pos	a	b	c	d	e	f	g	h	i	j	k
CO 1	x		x	x	x	x				x	x
CO 2	x		x	x	x	x				x	x
CO 3	x		x	x	x	x				x	x
CO 4	x		x	x	x	x				x	x

Course Title	**New and Renewable Energy Sources**		
Course number	EEC3220		
Credit Value	4		
Course Category	Core		
Pre-requisite			
Contact Hours (L-T-P)	3-1-0		
Type of Course	Theory		
Course Objectives	To introduce fundamentals of various renewable energy source and their technologies used to harness usable energy from solar, wind, ocean and Biomass energy sources.		
Course Outcomes	At the end of the course the students will be able to: 1. Identify renewable energy sources. 2. Understand the mechanism of solar energy resources and generation of power from solar energy. 3. Understand the mechanism of wind energy resources and generation of power from wind energy. 4. Understand the mechanism of biomass energy resources and generation of power from biomass energy.		
Syllabus	**Module**	**Topic**	**Lecture**
	Module-I	Introduction:	
		Energy Resources and their classifications,	12
		Geothermal energy generation systems,	
		Ocean tidal energy systems,	
		Fuel cell, energy storage,	

		Solar resources, passage through atmosphere.	
		Assignment/ Quiz/ Presentation/Tutorial	
	Module-II	<u>Solar Energy Conversion</u>	
		Solar thermal energy conversion	12
		Solar energy collectors	
		Solar thermal power plant	
		Solar PV conversion	
		Solar PV cell, V-I characteristics	
		MPPT	
		Solar PV power plant and applications	
		Assignment/ Quiz/ Presentation/Tutorial	
	Module-III	<u>Biomass Energy Conversion</u>	
		Usable forms of Biomass	12
		Biomass energy resources	
		Biomass energy conversion technologies	
		Ethanol blended petrol and diesel-biogas plants.	
		Energy farming.	
		Assignment/ Quiz/ Presentation/Tutorial	
	Module-IV	<u>Wind Energy Conversion</u>	
		Wind Energy estimation- Power extraction, Lift and drag forces	12
		Horizontal and vertical axis wind turbine	
		Wind energy conversion and control schemes	
		Integration of wind power plant with the grid-Power converters and control schemes	
		Assignment/ Quiz/ Presentation/Tutorial	
		Total No. of Lectures	**48**
Books*/ References	1. B. H. Khan, "Conventional Energy Source" Second Edition, Tata McGraw Hill, 2009 2. 2. J.W. Twidell & A.D. Weir, Renewable Energy Resources, (ELBS / E. & F.N. Spon., London). 3. Godfrey Boyle, Renewable Energy, Oxford, 2nd edition 2010. 4. C. S. Solanki, Solar Photovoltaic Technology and Systems, PHI, ISBN: 9788120347113		
Course Assessment/ Evaluation/ Grading Policy	**Sessional**	**Assignments / Quiz / Presentations (3 to 4)**	15 Marks
		Mid Term Examination (1 Hour)	25 Marks
		Sessional Total	**40 Marks**
	End Semester Examination (2 Hours)		60 Marks
		Total	**100 Marks**

<u>CO-PO Mapping</u>

Pos	a	b	c	d	e	f	g	h	i	j	k
CO 1	x			x		x					
CO 2	x	x		x	x	x	x			x	x
CO 3	x			x		x				x	
CO 4	x	x		x	x	x	x			x	

Course Title	Power Electronics–II
Course number	**EEC3210**
Credit Value	**4**
Course Category	**DC**
Pre-requisite	**Nil**
Contact Hours (L-T-P)	**3-1-0**
Type of Course	Theory
Course Objectives	To introduce the Power Electronic Devices, their gate drive circuits, design of commutation circuits, different types of dc-dc converters, ac regulators and their analysis, their control schemes and various types of inverter schemes.
Course Outcomes	At the end of the course the students will be able to 1. Use different power semiconductor devices for particular applications along their gate drive circuits. 2. Apply the principles of integral cycle and ac-phase control schemes. 3. Design PWM based converter control schemes. 4. Design dc-dc converters and apply them effectively for industrial applications. 5. Implement power electronic circuits with minimal harmonics.
Syllabus	**UNIT I: DC to DC Converters** Introduction to linear and switching converters. Buck, boost, buck-boost, Cuk converters. Analysis for voltage and current ripples. Isolated dc-dc converters: flyback, forward and push-pull converters. **UNIT II: AC to AC Converters** Principle of integral cycle and ac phase control. Analysis of single phase ac regulator with R and RL load. Thyristor controlled reactor (TCR). Three-phase ac –ac converters with various star and delta configurations. **UNIT III: DC-AC Converters** Principle of operation and analysis of single-phase square wave inverter with R, RL and RLC loads. Performance indices: THD, power factor distortion factor etc. Three-phase dc-ac converters: Basic circuits with ideal and practical switches. 180 degree and 120 degree conduction schemes, waveforms of phase and line voltages for star and delta connected loads, Fourier series and harmonic analysis. **UNIT IV: Voltage and Harmonic Control of DC-AC Converter** Voltage and harmonic control. PWM techniques: Single PWM, Multiple PWM, Sine-PWM, Phase displacement PWM and selective harmonic elimination. Harmonic analysis of output voltage.
Books*/References	1. *G.K.Dubey, et al, Thyristorised Power Controllers; New Age International, New Delhi. 2. M.H. Rashid, Power Electronics; PHI Learning, New Delhi 3. *Ned Mohan et al, Power Electronics, John Wiley and Sons 4. M. H. Rashid, Power Electronics Handbook, Academic Press, California 5. M. S. JamilAsghar, Power Electronics, PHI Learning

Pos	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	x			x		x				x	x
CO2	x	x		x	x	x	x			x	x
CO3	x			x		x				x	x
CO4	x	x		x	x	x	x			x	x

Annexure-III
Syllabi of B.E., B.Tech. Final Year Courses
Approved in BOS 10.02.2020

Course Title	**Power System Protection**	
Course Number	**EEC4310**	
Credits	**4**	
Course Category	**DC**	
Prerequisite Courses	**-**	
Contact Course	**2-1-0 (Lecture-Tutorial- Practical)**	
Type of Course	**Theory**	
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)	
Course Objectives	The course has been designed to fulfil the requirement of power industry. The course aims to provide basic fundamentals of power system protection schemes and equipment.	
Course Outcomes	After successful completion of this course students will be able to: 1. have the knowledge of different types of relays their constructional details and working. 2. implement the suitable protection scheme for different electrical equipment and transmission lines. 3. know about the formation of arc in C.B. and select appropriate C B to isolate the fault. 4. know about the causes of over voltages in electrical installation and use of appropriate device to protect it against them.	
Syllabus		**Lectures**
Unit I Protective Relay: Introduction and philosophy of protective relaying, Basic principles, construction and characteristics of electromagnetic relays; over current relay, differential relays, distance relay. Static relays and their realization, Elementary idea about µP based relays.		12
Unit II Protection Scheme: Protection of generators, transformers, bus bars, transmission line and motors. Computer aided protection.		12
Unit III Arc Interruption Theory and Circuit Breakers Formation and extinction of arcs, arc properties, Re-striking and recovery voltage. Different methods and control devices for arc extinction, Resistance and Capacitor switching, Current chopping. Different types of circuit breakers their construction , working principle and field of application .C.B. duties, ratings and testing.		12
Unit IV Power System Transients: Over voltages in transmission lines, lightning and switching surges, Transmission, reflection and refraction of surges, Ground wires, Spark gaps, Lightning arrestors, BIL and insulation coordination.		12
Total number of lectures		**48**

SUGGESTED READING / TEXTS / REFERENCES

1. B. Ram and Vishwakarma, Power System Protection & Switchgear, (TMH).
2. *Ravindranath and Chander, P.S. Protection & Switchgear, (Wiley Eastern).
3. C.R. Mason, Art and Science of Protection Relaying (Wiley Eastern).
4. Pataithankar and Bhide, Fundamentals of Power System Protection, (PHI).
5. Oza, Nair,Mehta and Makwana, Power System Protection & Switchgear, (TMH).

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO-1	x	x	x	x						x	x
CO-2	x	x	x	x						x	x
CO-3	x	x	x							x	x
CO-4	x	x	x							x	x

Course Title	**Power Station Practice**
Course Number	**EEE4310**
Credits	**3**
Course Category	**DE**
Prerequisite Courses	**Power System Analysis**
Contact Course	**2-1-0 (Lecture-Tutorial- Practical)**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The course has been designed to fulfil the requirement of power industry. The course aims to provide basic fundamentals of economics involved with power generation and Various techniques used optimization of generation cost.
Course Outcomes	After successful completion of this course students will be able to: 5. understand the economics of power generation. 6. understand tariff and power factor improvement methods used in power system. 7. apply design of various new technologies to optimize the economic operations. 8. have a deep knowledge of various components of substations.

Syllabus	Lectures
UNIT 1: ECONOMICS OF GENERATION Types of loads, demand factor, group diversity factor and peak diversity factor, load curve, load duration curve, load factor, capacity factor and utilization factor, base load and peak load stations, operating and spinning reserves, load forecasting, capital cost of power plants, depreciation, annual fixed and operating charges.	9
UNIT: 2: TARIFF AND POWER FACTOR IMPROVEMENT General tariff form and different types of tariffs, Tariff option for DSM. Causes and effect of low power factor, necessity of improvement and use of power factor improvement devices.	9
UNIT 3: COORDINATED OPERATION AND ELECTRICAL EQUIPMENTS Advantages of Coordinated operation of different types of power plants, hydrothermal scheduling: short term and long term. Coordination of various types of power plant. Governors for hydro and thermal generators, exciters and automatic voltage regulators.	10
UNIT 4: EHV SUBSTATION Layout of EHV substation, brief description of various equipment used in EHV substations, testing and maintenance of EHV substations equipment. Gas insulated substations (GIS).	8
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. *B. R. Gupta, Generation of Electrical Energy, (Eurasia Publishing House) 6th edition.
2. M. V. Deshpande, Elements of Electrical Power Station Design, PHI Learning Pvt. Ltd., 2009.
3. S. Rao, Electrical Substation-Engineering and Practice, (Khanna Publishers), 2015.
4. S.N. Singh, Electric Power Generation, Transmission and Distribution (PHI), 2nd edition.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO-1	x	X									
CO-2	x	X	x		x	x			x		
CO-3	x	X	x	x		x					

CO-4	x		x	x							

Course Title	**Digital Simulation of Power System**
Course number	**EEE4330**
Credit Value	**3**
Course Category	**PE**
Pre-requisite	**Power System Analysis**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The goal of the course is to analyze the power system operational behavior by digital simulation.
Course Outcomes	After successful completion of this course students will be able to: 1. Formulate the network matrices for various power system studies and carry-out short circuit calculation. 2. Understand the automatic generation control of active and reactive power as well as voltage control in power system. 3. Know about optimal operation/generation scheduling of generator. 4. Understand the functions of modern energy control center and SCADA system.

Module / Topic	Lecture
UNIT 1: SHORT CIRCUIT STUDIES Algorithms for formation of network matrices – Y_{BUS}, Y_{BR} and Z_{LOOP}; Z_{BUS} building. Representation of 3-phase networks. Short circuit studies using 3-phase Z_{BUS} matrix. Fault impedance and admittance matrices for various types of faults. Simulation example	9
UNIT 1: POWER SYSTEM CONTROL Load Frequency, Control Automatic generation control (AGC) in Single Area and Multi Area System, Tie Line bias control, AGC with Optimal Dispatch of Generation, Voltage control methods. Reactive power compensation. Simulation examples.	9
UNIT 3: OPTIMAL SYSTEM OPERATION Unit commitment. Optimal power flow solution, Hydro–Thermal load scheduling; short range and long range. Determination of Loss-Formula. Simulation example.	9
UNIT 4: COMPUTER CONTROL AND AUTOMATION Database for control: SCADA, State estimation. Contingency analysis and power system security assessment. Modern energy control centers.	9
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. *Hadi Sadat , Power System Analysis; (McGraw Hill)
2. Nagrath and Kothari, Power System Analysis; 4^{th} edition (McGrawHill)
3. El-Abiad and Stagg, Computer Methods in Power System Analysis; (McGrawHill)
4. Wood and Wollenberg, Power Generation Operation and Control; Wiley, NY
5. M. A Pai, Computer Techniques in Power System Analysis, Tata-McGrawHill

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x	x	x		x			x	x	
CO 2	x	x	x	x		x					
CO 3	x	x	x	x		x					
CO 4	x	x	x			x			x	x	

Course Title	**Modern Drives**
Course number	**EEE4110**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**Electrical Drives (EEC3110)**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce the operation of modern drives for speed control and closed-loop control operations. To analyze the operation and speed control of permanent magnet AC motors, vector-controlled induction motor drive, solar powered motor and reluctance motor drives.
Course Outcomes	At the end of the course the students will be able to 1. Analyze the requirement and characteristics of closed-loop drives. 2. Analyze the design of closed-loop synchronous motor drives. 3. Analyze the design of closed-loop permanent magnet motor drive. 4. Analyze the design of closed-loop reluctance motor and solar powered drives.

Syllabus	**Lectures**
UNIT 1: CLOSED-LOOP DRIVES Control requirements of electric drives: Steady-state, acceleration and deceleration modes. Closed-loop control of drives: Current-Limit control, Closed-loop Torque control and speed control, Closed-loop Speed control of Multi-motor Drives. Speed Sensing and Current Sensing. Current Regulated voltage source inverter Fed Drives. Closed Loop Control of DC Motor Drive for Armature as well as Field Control.	9
UNIT 2: PERMANENT MAGNET MOTOR DRIVES Permanent Magnet (PM) AC Motor Drives: PM materials and their characteristics, Sinusoidally excited and Trapezoidally excited motors. PM Synchronous Motor drive: Equivalent circuit, phasor diagram and relation for torque. Example of drive employing Sinusoidal PMAC motor fed from a current regulated voltage source inverter. Brushless DC Motor Drives: Basic circuit for the drive, torque relation, Example of a drive, application.	9
UNIT 3: VECTOR CONTROL OF INDUCTION MOTOR Dynamic model of induction motor, Park's and Clarke's transformations of three-phase variable. Torque equation in different reference frame variables. Vector control of induction motor: direct and indirect methods.	9
UNIT 4: SOLAR POWERED AD SWITCHED RELUCTANCE MOTOR DRIVES Review of solar PV characteristics: Motor suitable for pump drives, Centrifugal and reciprocating types of Pumps. Solar powered pump drives: Matched solar panel and drive characteristics for different cases. Switched Reluctance Motor: Introduction, Operation & control requirements and expression for torque and its derivation. Modes of Operation of reluctance motor: angle control and current control	9
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. G.K. Dubey, "Fundamentals of Electrical Drives" Narosa Pub. House, 2015.
2. B.K. Bose, "Power Electronics and Motor Drives – Advances and Trends", IEEE Press, 2006.
3. G.K. Dubey, "Power Semi-Conductor Controllers Drives" Printice-Hall 1989.
4. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control" Prentice Hall of India, 2002.
5. B. Wu, "High Power Converters ad A.C. drives", IEEE Press, John Wiley and Sons, Inc. 2006.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x		x		x			x		x
CO 2	x	x	X	x		x			x		x
CO 3	x	x	X	x		x			x		x
CO 4	x	x		x		x			x		x

Course Title	**Electric Vehicle and Traction**
Course Number	**EEE4120**
Credits	**3**
Course Category	**DE**
Prerequisite Courses	**None**
Contact Course	**3-0-0 (Lecture-Tutorial- Practical)**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce the concepts of Electric and hybrid vehicles.
Course Outcomes	After successful completion of this course students will be able to: 5. Choose a suitable drive scheme for developing an electric vehicle. 6. Design and develop basic schemes of electric vehicles and hybrid electric vehicles. 7. Choose proper energy storage systems for vehicle applications. 8. Able to understand energy management strategies applied in electric vehicle.

Syllabus	**Lectures**
UNIT 1: INTRODUCTION TO HYBRID AND ELECTRIC VEHICLES: History of hybrid and electric vehicles, basics of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.	9
UNIT 2: ELECTRIC TRACTION AND DRIVES Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, Introduction to electric components used in electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives	9
UNIT 3: ENERGY STORAGE AND SIZING OF DRIVE SYSTEM: 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, Matching the electric machine and the internal combustion engine, Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.	9
UNIT 4: ENERGY MANAGEMENT STRATEGIES: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies.	9
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. Text Book:
   Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. References:
   a) James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
   b) Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. NPTEL lecture notes.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x		x		x			x		x
CO 2	x	x	x	x		x			x		x
CO 3	x	x	x	x		x			x		x
CO 4	x	x		x		x			x		x

Course Title	**Power Quality**
Course Number	**EEE4320**
Credits	**3**
Course Category	**DE**
Prerequisite Courses	**None**
Contact Course	**2-1-0 (Lecture-Tutorial- Practical)**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The aim of this course is to make you competent in analyzing electrical circuits and to apply techniques to solve circuit problems using basic circuit theorems and other structured methods.
Course Outcomes	After successful completion of this course students will be able to: 1. Know various terms associated to power quality and need for power quality monitoring; 2. Understand the severity of power quality problems in power system and their harmful effects and to study mitigation techniques for these problems. 3. Understand the concepts related to power system reliability and estimate the impact of voltage sags on various appliances and drives. 4. Acknowledge the sources, causes and harmful effects of harmonics in power system and know mitigation techniques for reduction of harmonics and voltage sags in power system.

Syllabus	**Lectures**
UNIT 1: INTRODUCTION Introduction of the Power Quality (PQ) problem, Terms used in PQ: (Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, flicker, Voltage fluctuations, Transients, Interruption etc.) Causes and Effects of Power Quality Problems, Power Quality Standards (IEEE, IECand ANSI standards).	9
UNIT: 2: RELIABILITY OF POWER SUPPLY Difference between failures, outage and Interruptions – causes of long and short Interruptions, Overview of Reliability evaluation to power quality, Customer based reliability Indices (SAIFI, SAIDI, CAIDI, ASAI etc). and their calculation, Sources of Voltage sags, methods and equipment for mitigation of voltage sags.	9
UNIT 3: HARMONICS IN POWER SUPPLY IEEE standards for harmonics in current and voltages,Location Harmonic Sources, Sources of current harmonics (Transformers, Motors and Generators, Arc Furnaces, Electronic and Power Electronic Equipment), Difference between Current and Voltage Harmonics, Effects of harmonics on: Power factor, Overheating of Phase and Neutral Conductors, Motors and Generators, Capacitors, Transformers, Circuit-Breakers and Relays, Telecommunications systems. Mitigation: Introduction to Passive and active filters for mitigation of harmonics.	9
UNIT 4: SELECTED TOPICS IN POWER QUALITY Need for power quality monitoring and selection of monitoring equipment, Effect of Grounding on Power Quality, Power Quality issues of Grid connected Renewable Energy Sources, Importance of Energy Auditing and Distribution Automation.	9
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. C. Sankaran, 'Power Quality', CRC Press, 2002.
2. R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, ‘Electrical Power System Quality’, McGraw-Hill,1996.
3. Angelo Baggini (Ed.) Handbook of Power Quality, Wiley, 2008.

4. G.T. Heydt, ‘Electric Power Quality’, 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994).
5. Ghosh, G. Ledwich, Power Quality Enhancement Using Custom Power Devices. Kluwer Academic, 2002.
6. Beaty, H. and Santoso,S., Electrical Power System Quality, McGrawHill (2002).
7. Bollen, M.H.J., Power Quality Problems: Voltage Sag and Interruptions, IEEE Press (2007).

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO-1	x	x	x						x	x	
CO-2	x	x	x	x		x			x		
CO-3	x	x	x	x		x			x		
CO-4	x	x	x	x	x	x			x		

Course Title	**Power Semiconductor Controllers**
Course number	**EEE4210**
Credit Value	**4**
Course Category	**DE**
Pre-requisite	**Nil**
Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To give the practical exposure and the real world applications of different power electronic controllers.
Course Outcomes	After completing the course, the students should be able to know: 1. the state-of-the-art technological development in the field of power electronics, 2. the issues of power quality due to use of power semiconductor-based converters in power systems, 3. the practical aspect of different types of power electronic converters, 4. the relative merits and demerits of different converters, and 5. the application of different converters in renewable energy systems.

Syllabus	Lectures
UNIT 1: POWER ELECTRONIC DEVICES & CIRCUITS Recent advances in power devices, power modules, protection of devices and converters, heat management. Analysis of simple power electronic circuits with RL, RC and RLC type loads and dc / sinusoidal sources; performance of transformers for high frequency applications.	12
UNIT 2: POWER QUALITY Power quality problems and disturbances in power supply, definitions of PQ terms; PQ standard. Sources of voltage sag, voltage transients, nonlinear loads and current harmonics, voltage sag mitigation, over-voltage protection; shunt and series compensation.	12
UNIT 3: RESONANT CONVERTERS: Switched-mode inductive current switching, significance of ZVS and ZCS, classification of resonant converters, series and parallel load resonant converters, class-E converters, ZCS/ZVS resonant switch converters and their switch configurations, resonant ac/dc link converters and their circuit configurations.	12
UNIT 4: APPLICATIONS OF DIFFERENT CONTROLLERS UPS, multiple converters, application of different converters in solar and wind energy systems, distributed generation and smart grid, current trends in power electronics.	12
Total number of Lectures	**48**

SUGGESTED READING / TEXTS / REFERENCES

1. M. H. Rashid (Editor), Power Electronics Handbook, Academic Press, California.
2. M. H. Rashid, Power Electronics, PHI Learning, 3rded, New Delhi.
3. B. Singh, A. Chandra and K. Al-Haddad, Power Quality Problems and Mitigation Techniques, Wiley & Sons Ltd., West Sussex, UK.
4. I. Batarseh, Power Electronic Circuits, Wiley India Pvt. Ltd., New Delhi.
5. N. Mohan, T.M. Undeland and W.P. Robins, Power Electronics, 3rd ed., Wiley India Pvt. Ltd., New Delhi.
6. M. S. Jamil Asghar, Power Electronics, PHI Learning, New Delhi.

Reference Materials

1. B. K. Bose, Modern Power Electronics (collection of papers), Jaico Publications, New Delhi.
2. Effects of Harmonic Disturbances on Electrical Equipment, Electrical India, July 2005, pp. 48-54.
3. Power Quality Issues and Impacts, Proceedings of PICON-2011, 2011, pp. 85-93.
4. http://www.semiconductors.co.uk (D W Palmer)
5. Power Electronics Europe, Issue#7, 2008, International Rectifiers (http://www.irf.com)
6. http://schemit-walter.fbe.fh-darmstadt.de/cgi-bin/smps-e.pl?ue-min=48
7. http://www.IEEEXplore.org/Xplore/home.jsp
8. http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5456233
9. http://www.vispra.com/solar_hybrid_ups.phd

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x	x							x	x
CO 2	x								x	x	x
CO 3	x	x	x							x	x
CO 4	x	x	x						x	x	x

Course Title	**Modelling and Control of Power Electronic Converters**
Course number	**EEE4220**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**Nil**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To develop concept of modelling of Power Electronic Converters and designing of controller circuit.
Course Outcomes	At the end of the course the students will be able to: 5. develop modeling skills for Power Electronic Converters. 6. develop average circuit model of Power Electronic Converters circuits. 7. analyze the controller circuit of a Power Converter. 8. design controllers for Power Electronic Converter.

Syllabus	Lecture
UNIT 1: PRINCIPLES OF STEADY STATE CONVERTER ANALYSIS Inductor Volt-sec balance, Capacitor Charge balance, and the small ripple approximation, Steady state equivalent circuit modelling, losses and efficiency, Converter power circuits and discontinuous conduction mode	9
UNIT 2: CONVERTER CIRCUIT MODELING AC equivalent circuit modelling, state space averaging, Circuit averaging and average switch model with examples of few dc-dc converters	9
UNIT 3: CONTROL OF CONVERTERS Review of Bode Plot, Converter Transfer function and its analysis, Controller Design, Closed-loop Transfer function and negative feedback, example of converter control	9
UNIT 4: DESIGN OF CONTROLLERS FOR POWER CONVERTERS Stability, Regulator Design, Design of closed loop-controlled power converters.	9
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. Ned Mohan et al, "Power Electronics" John Wiley (SEA), 3rd Ed
2. Robert W Erickson et al, "Fundamental of Power Electronics" 2nd edition Kluwer Academic Publishers, USA, 2001
3. Daniel Hart, "Power Electronics", 2nd Edition, Mac Graw Hill Publishers.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x		x	x	x	x				
CO 2	x	x		x	x	x	x				
CO 3	x	x		x	x	x	x				
CO 4	x	x		x	x	x	x				

Course Title	**Solar PV System**
Course number	**EEE4230**
Credit Value	**3**
Course Category	**Departmental Elective**
Pre-requisite	**--**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To study and analyze the components, design and installation of the solar PV systems.
Course Outcomes	At the end of the course the students will be able to: 1. Classify different types of solar PV modules required and learn their performance index. 2. Analyze the different components of solar PV system. 3. Analyze different types of Solar PV Power System. 4. Design a suitable solar PV power system.

Syllabus	**Lectures**
UNIT 2: Solar PV Cell Technologies	**8**
Introduction to solar PV systems	1
Production of Silicon	1
Silicon Wafer based technologies	1
Thin Film Technology	1
Mono-crystalline, poly- crystalline and amorphous cells	1
Emerging Solar Cell technologies and concepts	2
UNIT 2: Solar PV Cell	**10**
Main features of terrestrial solar radiation, solar radiation spectrum, insolation	1
Generation of electron-hole pair by photon absorption	1
Solar cell i-v characteristics and p-v characteristics	1
Effect of variation of insolation and temperature on solar cell characteristics	1
Equivalent circuit of solar cell	1
Solar PV modules and arrays, module specifications	2
Mismatch in module characteristics and effect of shadowing	2
Energy Losses in PV modules and arrays	1
UNIT 3: Components of solar PV system	**9**
Maximum power point trackers	3
Batteries used in solar PV system, factors affecting battery performance	3
Charge controller	1
Inverters used in solar PV system	2
UNIT 4: Solar PV system Configurations	**9**
Various types of standalone PV configurations	1
Grid-connected solar PV systems with and without battery storage	2
System sizing and design methodologies	2
Hybrid PV systems	2
Life cycle costing of solar PV system	2
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. Photovoltaic Systems, 2nd Edition, by James P. Dunlop, Publisher: American, Technical Publishers, Inc. 2010
2. Photovoltaics: Design and Installation Manual, by Solar Energy International, Publisher- New Society Publishers, (2004).
3. C. S. Solanki, Solar Photovoltaic Technology and Systems, PHI

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x			x		x			x		
CO 2	x	x		x	x	x	x		x		
CO 3	x			x		x			x		
CO 4	x	x		x	x	x	x		x		

Course Title	**Power System Reliability**
Course Number	**EEE4340**
Credits	**3**
Course Category	**DE**
Prerequisite Courses	**None**
Contact Course	**2-1-0 (Lecture-Tutorial- Practical)**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The aim of this course is to make you competent in analysing the reliability of various components of power system and to apply techniques to evaluate the overall reliability of any system.
Course Outcomes	After successful completion of this course students will be able to: 1. know various terms associated with probabilistic calculation and need for power system reliability evaluation; 2. solve problems on various power system reliability indices. 3. understand the concepts related to power system reliability for complex networks. 4. perform mathematical modelling of various power system components.

Syllabus	**Lectures**
UNIT 1: REVIEW OF PROBABILITY THEORY Element of probability theory, Probability distribution, Random variable, Probability density & distribution functions, Mathematical expectation, Probability distribution functions.	8
UNIT: 2: RELIABILITY PRINCIPLES Failure rate model, Bathtub curve, Mean time to failures, Reliability of complex systems: Series systems, parallel systems, Partially redundant systems, Bayes' theorem, Customer based reliability Indices (SAIFI, SAIDI, CAIDI, ASAI etc.) and their calculation. MARKOV process, Long term reliability.	10
UNIT 3: RELIABILITY ANALYSIS OF COMPLEX NETWORK State enumeration methodologies, Network reduction methods: minimum tie-set, minimum cut-set and decomposition methods, Reliability of engineering systems, Component reliability, Hazard models, Reliability of systems with non-repairable components, Bayes' theorem in reliability, Construction of fault tree diagram.	9
UNIT 4: RELIABILITY OF ENGINEERING SYSTEMS Reliability model of a generating unit, State space methods, combining states, Sequential addition method, Load modelling, Cumulative load model, Merging of generation and load models, Loss of load probability, percentage energy loss, Probability and frequency of failure, Distribution system reliability, Composite System Reliability.	9
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. J. Endreny, Reliability Modeling in Electric Power Systems, John Wiley & Sons, 1979.
2. Roy Billinton & Ronald Nallan, Reliability Evaluation of Power systems, Plenum Press, New York, 1996.
3. Ali A. Chaudhary, Don O. Koval, Power Distribution System Reliability Practical Methods and Applications, John Wiley & Sons, 2009.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO-1	x	x									
CO-2	x	x	x								
CO-3	x	x	x	x		x					
CO-4	x	x	x	x	x	x					

Course Title		**Generalised Theory of Electrical Machines**
Course Number		**EEE4130**
Credit Value		**3**
Course Category		**DE**
Pre-requisite		**EEC2110, EEC2120**
Contact Hours (L-G-P)		**2-1-0**
Type of Course		**Theory**
Course Assessment		Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce the concepts of mathematical modeling and generalized model of electric machines and to derive torque and phasor expressions of common electric machines.	
Course Outcomes	At the end of the course the students will be able to: 1. Apply the knowledge of mathematical model of machines and use them effectively. 2. Suggest a particular type of machine for an application. 3. Analyse the performances of DC motors and repulsion motor. 4. Analyse the performances of AC motors.	

Syllabus	Lectures
UNIT 1: MATRIX EQUATIONS Matrix equations of two winding and three winding transformers, basic commutator machines, slip ring and squirrel cage machines. Balanced two-phase machine with uniform air gap, two phase revolving armature machine with salient poles, transformed impedance matrix.	9
UNIT 2: TORQUE EXPRESSION IN AC MACHINES Energy stored in magnetic field, derivation of torque expressions, mean steady state torque in ac machines and its direction.	9
UNIT 3: COMMUTATOR MACHINES Performance calculations, phasor diagram and equivalent circuits of series, shunt and separately excited dc machines, repulsion motor.	9
UNIT 4: STEADY STATE PERFORMANCE OF POLY-PHASE MACHINES Performance calculations, phasor diagram and equivalent circuits of balanced iinduction machines and synchronous machines with salient pole and non-salient poles constructions.	9
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. *H. N. Hancock, “Matrix Analysis of Electric Machines”.
2. Adkins, “Generalized Theory of Electric Machines”.

CO-PO Mapping

POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO1	x	x		x		x			x		x
CO2	x	x	x	x		x			x		x
CO3	x	x	x	x		x			x		x
CO4	x	x		x		x			x		x

Course Title	**Machine Learning**
Course number	**EEE4720**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**-**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	This course will serve as a comprehensive introduction to various topics in machine learning. At the end of the course the students should be able to design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate and interpret the results of the algorithms.
Course Outcomes	At the end of the course the students will be able to: 1. Interpret the fundamental concepts of AI such as Knowledge representation and problem solving 2. Express the fundamental of Machine Learning, its necessity, advantages and limitations 3. Examine various techniques of Machine learning. Infer the fundamental concepts of pattern recognition techniques.

Syllabus	**Lectures**
UNIT 1 – INTRODUCTION TO AI Introduction to Artificial Intelligence (AI) and Rule based expert system, Fundamental characteristics of an expert system, Uncertainty management in rule-based expert systems, Basic probability theory, Bayesian reasoning.	9
UNIT 2 - MACHINE LEARNING INTRODUCTION Introduction to Machine Learning, Associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning.	9
UNIT 3 – MACHINE LEARNING ML Techniques overview, Validation Techniques (Cross-Validations) Feature/Dimensionality reduction, Decision trees, Statistical learning models, Reinforcement learning.	9
UNIT 4 – PATTERN RECOGNITION Introduction to Pattern recognition, Parameter estimation methods - Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Classification Techniques.	9
Total Number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems (3rd Edition) 2006.
3. Stuart Russell and Peter Norvig Artificial Intelligence: A Modern Approach, 2nd edition, Prentice Hall of India, 2004.
4. Margaret H. Dunham. Data Mining: introductory and Advanced Topics, Pearson, 2006

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x	x		x					x	
CO 2	x	x	x		x					x	
CO 3	x	x	x		x	x					
CO 4	x	x	x		x	x					

Course Title		**Process Instrumentation and Control**
Course number		**EEE4520**
Credit Value		**3**
Course Category		**DE**
Pre-requisite		**Nil**
Contact Hours (L-T-P)		**2-1-0**
Type of Course		**Theory**
Course Assessment		Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce the methods for the measurement and control of industrial process variables as per the given performance criteria in electrical, pneumatic, hydraulic as well as digital domain.	
Course Outcomes	After completing the course, the students should be able to: 1. understand various process control systems and develop mathematical models for processes. 2. apply methods for the measurement of industrial process variables and select actuators/controllers in different domains. 3. design the controllers as per the given criteria in time as well as frequency domain. 4. create PLC programs for industrial process and appreciate methods of computer-based control.	

Syllabus	Lectures
MODULE I Elements of process control loop. Mathematical model of Flow, Level, Pressure and Thermal processes. Interacting and non-interacting systems, Degrees of freedom, cascade and feed-forward control. *Modes of control action:* two position, floating, P, PI, PID.	9
MODULE II Electric, Pneumatic and Hydraulic Controllers. *Control valve:* characteristics and sizing. *Measurement of Process Variables:* Measurement of flow, pressure, temperature, liquid level and humidity.	9
MODULE III *Tuning of controllers:* Quarter Amplitude Criterion, controller performance criterion, Methods of process loop tuning, Ziegler Nichols open and closed loop methods, Frequency response methods.	9
MODULE IV *Data logging. Computer supervisory control, Direct digital control*, PLC Architecture, Input and output modules, specifications, PLC programming for process applications.	9
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. *C.D. Johnson, Process Control Instrumentation Technology (PHI).
2. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004.
3. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Process Dynamics and Control”, Wiley John and Sons, 2nd Edition, 2003.
4. D. Patranabis, Principles of Industrial Instrumentation (Tata McGraw Hill).

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x								x	x
CO 2	x	x								x	x
CO 3	x	x	x								
CO 4	x	x	x	x		x					

Course Title	**Measurement and Data Acquisition**
Course number	**EEE4510**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**Nil**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce the characteristics of the sensors for measurement, signal conditioning of the data, acquisition of the data, and methods of their communication.
Course Outcomes	After completing the course, the students should be able to: 1. select sensors based on their characteristics. 2. apply conditioning of the signal to be measured or acquired. 3. apply the methods of data acquisition and multiplexing on the measured data. 4. distinguish various signal transmission and communication techniques.

Syllabus	**Lectures**
MODULE I Static & dynamic characteristics of sensors. Calibration of sensors. Sensor responsiveness, zeroth, first, and second order sensors. Decibel plots. Sample and hold circuits. Time constant of sensors.	9
MODULE II DAQ signal conditioning – signal conditioning using filter circuits. Analog filters – design of passive filter. OPAMP circuits – Amplification and mathematical properties. Zero crossing. Peak and Window detector. Instrumentation amplifier AD620 and its interfacing.	9
MODULE III Data acquisition system. ADCs, DACs, Multiplexing techniques. PC-based data acquisition with practical examples. Sensor interfacing using DAQ cards. Recent practices in the measurement of temperature, pressure, flow, voltage & current.	9
MODULE IV Signal transmission. Noise and Interference. Grounding and shielding Serial data transmission methods. RS232-C, 4-20 mA current loop, GPIB/IEEE488, LAN, USB, HART protocol, Fieldbus, Modbus.	9
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. Anand, M.M.S., Electronic Instruments and Instrumentation Technology, PHI, 2004.
2. Murthy D.V.S. Transducers and Instrumentation, PHI, 2006.
3. Recent references, Industry product manuals etc.
4. Doebelin E., Measurement Systems, 5^{th} ed., Tata McGraw-Hill, 2004.
5. Giorgio Rizzoni, Principles and Applications of Electrical Engineering (SIE), Tata McGraw-Hill, 5^{th} edition.

CO-PO Mapping

POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO 1	x	x								x	x
CO 2	x	x	x	x						x	x
CO 3	x	x	x	x						x	x
CO 4	x	x								x	

Course Title	**Smart Grid**	
Course number	**EEE4360**	
Credit Value	**3**	
Course Category	**DE**	
Pre-requisite	**Power Systems**	
Contact Hours (L-T-P)	**3-1-0**	
Type of Course	**Theory**	
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)	
Course Objectives	To gain knowledge on formulation and application of optimal control problems. To study and understand various optimal control techniques and their application in solution to optimal control problem.	
Course Outcomes	At the end of the course the students will be able to 1. Have complete familiarity with the concept and features of a smart grid. 2. Apply the PMU based state estimation on smart grid. 3. Model different components of smart grid 4. Formulate demand response and energy management programs for smart grid.	

Syllabus	**Lectures**
MODULES 1 Introduction to Smart Grid, Architecture of Smart Grid, Smart Grid standards and policies, Smart Grid control layer and elements. Distributed generation resources, Smart Grid components control elements, Smart Grid Technologies, Plug-in-Hybrid Vehicles (PHEV). Assignment/ Quiz/ Presentation	9
MODULES 2 State Estimation for low voltage networks, Smart Grid Monitoring, Phasor measurement units, Phasor estimation, Dynamic Phasor estimation. Assignment/ Quiz/ Presentation	9
MODULES 3 Operation and control of AC Smart Grid, Operation and control of DC Smart Grid, Simulation and case study of AC microgrid. Assignment/ Quiz/ Presentation	9
MODULES 4 Demand side management of Smart Grid, Demand response analysis of Smart Grid, Energy Management. Assignment/ Quiz/ Presentation	9
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. *Janaka B. Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Smart Grid: Technology and Applications, Wiley, 2012.
2. NPTEL lectures/notes and MIT open courseware.
3. Relevant Journals/ Magazines / Transaction papers.

CO-PO Mapping

POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO 1	x							x	x	x	x
CO 2	x	X	x						x	x	x
CO 3	x	X	x						x	x	x
CO 4	x	X	x						x	x	x

Course Title	**Digital Signal Processing**
Course number	**EEE4820**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**Basic Course on Signals and Systems**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To cover the techniques of modern digital signal processing that are fundamental to a wide variety of signal processing applications, with an emphasis on the design techniques for digital filters.
Course Outcomes	At the end of the course the students will be able to: 1. Interpret, represent and process discrete signals and systems. 2. Understand frequency domain analysis of discrete time signals. 3. Analyze and design FIR and IIR filters.

Syllabus	**Lectures**
UNIT 1: DISCRETE-TIME SIGNALS AND SYSTEMS Review of Discrete time signals; Frequency analysis of discrete time signals; Transform analysis of Linear Time Invariant systems. Home Assignment/ Tutorial	10
UNIT 2: DISCRETE FOURIER TRANSFORM Discrete Fourier Transform (DFT); Circular shift and convolution; Fast Fourier Transform – Decimation in time (DIT) and Decimation in frequency (DIF) algorithms. Home Assignment/ Tutorial	10
UNIT 3: IIR FILTERS Introduction to Infinite Impulse Response (IIR) filters; Basic Structures for IIR systems; Design of IIR filters. Home Assignment/ Tutorial	08
UNIT 4: FIR FILTERS Basic Structures for Finite Impulse Response (FIR) systems; Characteristics of FIR filters; Design of FIR filters. Home Assignment/ Tutorial	08
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. *J. G. Proakis, D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and applications, 4th edition, Pearson Education, 2007.
2. A. V. Oppenheim and R. W. Schafer, Discrete Time Signal Processing, Pearson Education.
3. S. K. Mitra, Digital Signal Processing, A Computer-Based Approach, Tata McGraw-Hill.
4. R G Lyons, Understanding Digital Signal Processing, Pearson Education.
5. A. Antoniou, Digital Filters: Analysis, Design and Applications, Tata McGraw Hill.

POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO 1	x	x			x	x				x	x
CO 2	x	x			x	x				x	x
CO 3	x	x	x	x	x	x				x	x

Course Title	**Non-Linear Control Systems**
Course number	**EEE4430**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**Engineering Mathematics, Dynamic System Analysis**
Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To develop the understanding of the dynamic behavior of non-linear systems and to introduce the methods for the stability analysis for non-linear systems
Course Outcomes	After completing the course, the students should be able to: 1. represent non-linear systems in various forms for the analysis of their dynamic behavior. 2. analyze non-linear systems with mathematical tools. 3. perform stability analysis on non-linear systems using Lyapunov`s theory. 4. analyze non-linear systems for stability and robustness in frequency domain.

Syllabus	**Lectures**
MODULE I State-space representation of nonlinear systems, Feedback systems in standard form, Basic characteristics of nonlinear systems, Classification of nonlinearities. Describing functions, Phase plane analysis, Classification of equilibrium points, Systems with multiple equilibria. Bifurcation Diagrams.	9
MODULE II Mathematical preliminaries: Linear vector spaces - Norms and inner products, Normed and inner product spaces, Nonlinear differential equations - Existence and uniqueness. Limit cycle analysis of control systems.	9
MODULE III Lyapunov's direct and indirect methods of stability analysis. Region of attraction. La Salle theorems: Invariance principle, singular perturbation,	9
MODULE IV Frequency Domain Analysis of Feedback Systems: Absolute stability (Lure) problem, Sliding Mode Control, Basics of Robust Control in Non-Linear Systems.	9
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. H. K. Khalil, "Nonlinear Systems," Prentice Hall, N.J., 2002.
2. H. J. Marquez, Nonlinear Control Systems: Analysis and Design, John Wiley Inter science, 2003.
3. J. J. Slotine and W. Li Applied Nonlinear Control, Prentice-Hall, 1991.
4. M. Vidyasagar, Nonlinear Systems Analysis, SIAM, 2002

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x								x	x
CO 2	x	x								x	x
CO 3	x	x	x								
CO 4	x	x	x	x		x					

Course Title	Mechatronic Systems
Course number	EEE4440
Credit Value	3
Course Category	DE
Pre-requisite	Measurement, Power Electronics
Contact Hours (L-T-P)	3-1-0
Type of Course	Theory
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To gain knowledge on formulation and application of optimal control problems. To study and understand various optimal control techniques and their application in solution to optimal control problem.
Course Outcomes	At the end of the course the students will be able to 1. have complete familiarity with the concept and formulation of the Mechatronic systems. 2. develop microcontroller-based solutions. 3. design a Ladder Logic based program for a given application 4. design a Mechatronic System.

Syllabus	Lectures
MODULE 1: INTRODUCTORY CONCEPTS The Mechatronics approach, Elements of a Mechatronic system. Sequential Controllers. Sensors in Mechatronics and their selection. MEMS and Nano Technologies in Mechatronic systems. Robotic Systems: Introduction to anatomy, drives, transmitters and effectors of Robotics. Assignment/ Quiz/ Presentation	9
MODULE 2: EMBEDDED SYSTEMS & MICROCONTROLLER Embedded systems. Real time control. Microcontrollers. Review of architecture and programming of the 8051 microcontrollers; Interfacing 8051 to the real world: ADC, DAC, sensors and stepper motor. Assignment/ Quiz/ Presentation	9
MODULE 3: PROGRAMMABLE LOGIC CONTROLLER Architecture, Ladder diagram programming, Timers, Internal Relays and Counters, Shift Registers, Master and Jump Controls, Data Handling, Selection of a PLC, Applications, Case studies and Design examples. Assignment/ Quiz/ Presentation	9
MODULE 4: DESIGN AND APPLICATIONS OF MECHATRONIC SYSTEMS Comparison of conventional and Mechatronic design of physical systems. Fault detection techniques, Autotronics, Bionics and Avionics: Case studies and design examples. Assignment/ Quiz/ Presentation	9
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. * W. Bolton, "Mechatronics", Pearson Education, 2005
2. NPTEL lectures/notes and MIT open courseware.
3. Relevant Journals/ Magazines / Transaction papers.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x							x	x	x	x
CO 2	x	x	x						x	x	x
CO 3	x	x	x						x	x	x

CO 4	x	x	x						x	x	x

Course Title	**Numerical Computational Methods in Electrical Engineering**
Course number	**EEE4710**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**Nil**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	1. To equip the student to evaluate and analyze the approach for solving Engineering problems using state of the art modeling and simulation tools, 2. To provide a foundation in utilizing computational tools for real-time applications using data acquisition, data analysis, graphical visualization, algorithm development etc.
Course Outcomes	Upon successful completion of this course, the students: 1. would be able to use computational tools to write creative programs to analyze basic engineering problems. 2. would be able to write MATLAB script programming utilizing the tools and functions of MATLAB. 3. would develop a basic understanding of the user interface (UI), schematic capture and simulation to evaluate, design and debug engineering models 4. would develop proficiency in specialized software tool LabVIEW®

Syllabus	Lectures
UNIT I: INTRODUCTION Introduction to algorithmic development and application of algorithmic thinking to solve electrical engineering problems using computer. Study of numerical methods to solve for roots of an equation, to numerically evaluate integrals, to solve simple ordinary differential and linear algebra equations. Analysis of errors when using arithmetic operations. Data structures, sorting and searching	9
UNIT II: PROBLEM SOLVING THROUGH MATLAB® (Matrix Laboratory) Basics of MATLAB, Creating and Manipulating matrices, Cell arrays, Structures, Plotting: 2-D and 3-D plots, Creating and running of a function, Function definition line, File I/O handling, M-file debugging, Implementation of FOR and WHILE loops, Root finding, Data analysis, Polynomials, Curve fitting, Interpolation, Ordinary differential equations,	9
UNIT III: SIMULINK® Introduction, Block diagram, Functions, Creating and working with models, Defining and managing signals, Running a simulation, analyzing the results Circuit analysis applications, Control system applications, file I/O, building GUIs	9
UNIT IV: INTRODUCTION TO LABVIEW® (Laboratory Virtual Instrumentation Work Bench), Introduction to the LabVIEW® Application Development Environment (Front Panels, Block Diagrams, Tools palettes), Creating Virtual Instrument in LabVIEW®, Dataflow programming concepts, Sub VIs and modular code creation, Data Acquisition and data Analysis.	9
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. *D Hanselman and B Littlefield, Mastering MATLAB® , Pearson Education, 2011
2. *Robert Bishop, Learning with LabVIEW®, Prentice Hall, 2015
3. J. Brockman, Introduction to Engineering: Modeling and Problem Solving, Wiley, 2008

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x	x	x	x	x				x	x
CO 2	x	x	x	x	x	x				x	x
CO 3	x	x	x	x	x	x				x	x
CO 4	x	x	x	x	x	x				x	x

Course Title	**Embedded Systems**
Course number	**EEE4420**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**Nil**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	To introduce the students about the working principles of embedded systems and their communication.
Course Outcomes	After completing the course, the students should be able to: 1. distinguish the components and architecture of embedded systems. 2. distinguish various memory devices, input/output and interrupt methods. 3. design embedded processors/components and apply various communication methods. 4. manage memory, input-output, drivers in Real Time Operating Systems

Syllabus	**Lectures**
Module I Embedded Processing Systems: Introduction, Components of Embedded Systems, Embedded Processor, Microcontrollers architectures (PIC and ARM), DSP and ASICs and SoC.	9
Module II Memory Devices: ROM and RAM family, Interfacing Memory, Simple I/O programming, Interrupts and their servicing, Timing Devices and Interfacing, Analog I/O Techniques.	9
Module III Design of Embedded Processors and Components, Embedded Communication: Parallel Bus Standards, Serial Bus Standards, Networking Standards and Wireless Standards.	9
Module IV Concept of Real Time Operating Systems (RTOS): Introduction, Memory and I/O Management, Device Drivers. Practical examples of embedded systems using Atmega (or other relevant microcontroller).	9
Total number of Lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

Text Books:

1. W. Wolf, *Computers as Components: Principles of Embedded Computing System Design, 2nd Ed.*, Burlington, 2008.
2. T Noergaard, *Embedded Systems Architecture: A comprehensive Guide for Engineers and Prgrammers,* Elsevier, Oxford, 2005.

Reference Books:

3. Steve Heath, *Embedded System Design, 2nd Edition*, Newnes, Burlington, 2003.

CO-PO Mapping

POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO 1	x		x	x						x	x
CO 2	x		x	x		x				x	x
CO 3	x		x	x		x				x	
CO 4	x		x	x		x				x	

Course Title	**HVDC and FACTS Technology**
Course number	**EEE4350**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**EEC3210, EEC3310**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The objectives of the course are to make the student understand the concept of HVDC Power Transmission and its comparison with the EHVAC Transmission. They will also learn the recent trends in the transmission system with the use of different FACTS controllers.
Course Outcomes	At the end of the course the students will be able to: 1. Learn modern Trends in DC Transmission and analyze HVDC link performance including the control of HVDC 2. Analyze 3-phase Converter Circuits. 3. Know the basic concepts of FACTS technology, its objectives and the comparison with HVDC. 4. Know different type of FACTS controllers and their analysis

Syllabus	Lectures
UNIT 1: HVDC POWER TRANSMISSION TECHNOLOGY Introduction, Classification of DC links, Advantages & Comparison of EHVAC & DC Transmission, Applications, Modern Trends in DC Transmission, Components of HVDC converter stations	9
UNIT 2: CONVERTER CIRCUITS 3-phase converter circuits (Graetz Circuit) and its analysis, Cascading of converters, Converter control characteristics, Introduction to VSC transmission	9
UNIT 3: TRANSMISSION PROBLEMS AND NEEDS Recent developments and problems, Transmission System Compensations, Flexible AC Transmission Systems (FACTS), Objectives of FACTS, Basic types of FACTS Controllers, HVDC Versus FACTS	9
UNIT 4: FACTS CONTROLLERS Thyristor controlled FACTS Controllers, Converter based FACTS Controllers, Static VAR Compensator (SVC): Operation & analysis, Thyristor Controlled Series Capacitor (TCSC): Operation & analysis.	9
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. *K.R.Padiyar HVDC Power Transmission System: Technology and System Interactions (Wiley).
2. E.W. Kimbark Direct Current Transmission Vol. I (Wiley).
3. P. Kundur: Power System Stability and Control, Tata McGraw-Hill Education, 1994.
4. N. G. Hingorani and L. Gyugyi* Understanding FACTS: Concepts and Technology of Flexible AC Transmission System. IEEE Press. 2000.
5. R. M. Mathur and R. K. Verma Thyristor-based FACTS Controllers for Electrical Transmission Systems, IEEE press, Piscataway, 2002.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x									
CO 2	x	x		x							
CO 3	x			x			x				

CO 4	x	x			x					x	x

Course Title	**Artificial Neural Networks**
Course number	**EEE4730**
Credit Value	**3**
Course Category	**DE**
Pre-requisite	**Basics of Probability Theory, Linear algebra and Calculus**
Contact Hours (L-T-P)	**2-1-0**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	This course will serve as a comprehensive foundation to various topics in neural networks. At the end of the course the students should be able to design and implement neural network based solutions to classification, regression, and optimization problems.
Course Outcomes	At the end of the course the students will be able to: 1. Comprehend the concepts of ANN, understand appropriate learning rules for each of the architectures. 2. Identify several neural network architectures, algorithms, applications and limitations. 3. Examine various techniques of Supervised and Unsupervised learning. 4. Infer the concepts of different networks and solve engineering problems.

Syllabus	Lectures
UNIT 1: INTRODUCTION Biological Neurons, Structure and function of a single neuron, Models of a neuron, Neural network architecture, Activation functions, Learning rules, Perceptron, Perceptron convergence theorem. Single layer networks and its limitations.	10
UNIT 2: MULTI-LAYER PERCEPTRON Multilayer Networks, Learning Algorithm – Back propagation, Convergence and optimization, Cross Validation, Virtues and limitations of back propagation learning,	10
UNIT 3: RADIAL BASIS FUNCTION Introduction, Generalized radial-basis function networks, Properties of RBF networks, Comparison of RBF networks and Multilayer Perceptron.	6
UNIT 4: UNSUPERVISED NETWORKS Self-organizing networks, Kohonen's Self Organizing Maps and its algorithm, Self-Organizing feature map; K-means and K-median Clustering: algorithm, optimization and limitations. Typical applications of Artificial Neural networks.	10
Total number of lectures	**36**

SUGGESTED READING / TEXTS / REFERENCES

1. Simon Haykin, Neural Networks: a Comprehensive Foundation, PHI edition.
2. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
4. Tariq Rashid, Make your own neural network, CreateSpace Independent Publishing Platform, 2016.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x	x		x					x	
CO 2	x	x	x		x					x	
CO 3	x	x	x		x	x					

CO 4	x	x	x		x	x					

Course Title	**Dynamic System Analysis**	
Course number	**EEC3410**	
Credit Value	**4**	
Course Category	**DC**	
Pre-requisite	**Signals and systems**	
Contact Hours (L-T-P)	**3-1-0 (L-T-G)**	
Type of Course	**Theory**	
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)	
Course Objectives	The objective of the course is to introduce the concepts in the analysis and design of control systems. To focus on general concept of control systems incorporating modelling and performance analysis with potential application to engineering systems.	
Course Outcomes	At the end of the course the students will be able to 5. Apply the time domain and frequency domain concepts for system modelling. 6. Apply the State Space representation and use it for the stability analysis of the dynamic systems. Design system model using MATLAB. 7. Analyze the system using time domain and frequency domain techniques and suggest the relative stabilities of different dynamic systems 8. Design and compare different types of controllers/compensators and apply control systems theory to a real engineering system.	
Syllabus		**Lectures**
UNIT 1: CONTROL CONCEPTS AND MATHEMATICAL MODELLING System concepts, Effect of Feedback, System Modelling, Transfer Function, and Modelling of mechanical, electrical, and hydraulic systems. Analogy between the elements of different types of systems. State Variable Representation. Relationship between State Model and Transfer Function.		12
UNIT 2: SYSTEM REPRESENTATION AND CONTROL COMPONENTS Block Diagram Algebra. Signal Flow Graph and Mason's Gain Formula. Numerical simulation using MATLAB and Simulink for linear time invariant systems. Applications of Synchro, Tachogenerator, Servomotor and Stepper motor in control systems.		12
UNIT 3: TIME RESPONSE ANALYSIS Time response of First Order and Second Order systems. Steady State Error and Error Coefficients. State Transition Matrix and solution of State Equations. Concepts of Stability –Routh-Hurwitz criterion of Stability. Root Locus technique. Introduction to P, PI and PID controllers.		12
UNIT 4: FREQUENCY RESPONSE ANALYSIS AND CONTROL SYSTEM DESIGN Frequency response of second order system. Bode Plots, Polar Plots, Nyquist stability criterion, Gain margin and phase margin. Correlation between Time and Frequency response. Cascade and feedback compensation – design of lag, lead, lag-lead compensators.		12
Total number of Lectures		**48**

SUGGESTED READING / TEXTS / REFERENCES

1 *B.C.Kuo Automatic Control Systems, Prentice Hall of India, 2002.
2 *Norman S. Nise Control Systems Engineering, Wiley Eastern, 2007
3 K. Ogata, Modern Control Engineering, Prentice Hall of India, 2003.
4 Nagrath and Gopal, Control System Engineering, New Age, 2007
5 Samarjit Ghosh, Control systems, Pearson
6 Nagrath and Gopal Control System TMH, 2002.
7 B.S.Manke, Linear Control Systems, Khanna
8 NPTEL lectures/notes and MIT open courseware.

9 Relevant Journals/ Magazines / IEEE Transactions on Automatic control.

CO- PO Mapping

POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CO 1	x	x		x						x	x
CO 2	x	x		x		x			x	x	x
CO 3	x	x								x	x
CO 4									x	x	x

Course Title	**Control System**
Course number	**EEC4410**
Credit Value	**4**
Course Category	**DC**
Pre-requisite	**Dynamic Systems Analysis**
Contact Hours (L-T-P)	**3-1-0 (L-T-G)**
Type of Course	**Theory**
Course Assessment	Course Work (Home Assignments) (15%) Mid Semester Examination (1 hour) (25%) End Semester Examination (2 hour) (60%)
Course Objectives	The objective of the course is to introduce the concepts in the analysis and design of discrete data and nonlinear control systems. To focus on general concept of control systems incorporating modelling and performance analysis with potential application to engineering systems.
Course Outcomes	At the end of the course the students will be able to: 1. Apply the concepts of discrete data control system modelling and their stability analysis. 2. Design dynamic systems using the state space representation. 3. Analyze the nonlinear systems using linearization techniques. 4. Apply the phase plane concepts and Liapunov's theory for analysis of nonlinear systems.

Syllabus	Lectures
UNIT 1: DISCRETE DATA SYSTEMS Sampled data and digital control systems, Sampler and Hold circuit, Review of Z-transform, Pulse Transfer Function, Block diagram algebra, State variable representation of discrete data systems, Stability analysis.	12
UNIT 2: DESIGN IN STATE SPACE Controllability and Observability, Linear Transformation, Pole placement using state feedback, Output feedback-full and reduced order observer, Stabilizability and Detectability	12
UNIT 3: NON-LINEAR SYSTEMS AND LINEARIZATION Introduction to Non-linear systems and their state variable representation, Linearization, Describing function of various non linearities, Stability analysis using describing function	12
UNIT 4: PHASE PLANE AND STABILITY ANALYSIS Introduction to phase plane, Singular points of second order system, Construction of phase trajectories using analytical and graphical methods, Stability of nonlinear systems, Liapunov's stability analysis and methods of construction of Liapunov's function.	12
Total number of Lectures	**48**

SUGGESTED READING / TEXTS / REFERENCES

1 * Nagrath and Gopal Control System Engineering, New Age, 2007
2 B. C. Kuo, Digital Control System, Oxford University Press
3 Stefani, Shahian, Savant, Hostetter, Design of Feedback Control Systems, Oxford University Press, 2004
4 Khalil, Nonlinear Systems, Pearson, 2019.
5 M. Rihan, Advanced Control Systems, AXIOE Books, 2011
6 NPTEL lectures/notes and MIT open courseware.

CO-PO Mapping

POs	a	b	c	d	e	f	g	h	i	j	k
CO 1	x	x							x	x	x
CO 2	x	x	x	x	x	x		x	x		x
CO 3	x										
CO 4	x	x	x			x			x	x	x