GOVT. COLLEGE OF ENGINEERING, AMRAVATI

DEPARTMENT OF ELECTRICAL ENGINEERING

CURRICULUM

For

B. TECH. (Electrical Engineering)

2022- 2023

Member Secretary (Dr. R.B. Sharma)	Chairman, BoS (Dr. P.P. Bedekar)		Principal (Dr. A.M. Mahalle)

PROGRAM OBJECTIVES

PEO1: Graduates will possess fundamental knowledge of science, mathematics and electrical engineering and demonstrate expertise in problem solving, analysis and design related to electrical systems.

PEO2: Graduates will be suitable to work in private and public sector, electric utilities, various departments of Central/State/Local Governments, various sectors of Indian industries, multinational corporations and one fifth of them will pursue higher education in chosen field of engineering or management.

PEO3: Graduates will be ethical professionals, sensitive to society and engaged in lifelong learning to remain effective members of their communities/teams and will demonstrate leadership and lifelong learning attitude.

PROGRAM OUTCOMES (POs):

1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research0based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life0long learning: Recognize the need for, and have the preparation and ability to engage in independent and life0long learning in the broadest context of technological change.

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Semester I

Teaching Scheme							Evaluation Scheme						
Category	Course Code	Course Title	Theory	Tutorial	Practical		Theory			Practical		Total	Credits
			Hrs/week	Hrs/week	Hrs/week	Total	MSE	TA	ESE	ICA	ESE		
MC	SHU100	Induction Program	Two weeks mandatory audit course										0
BSC	SHU121	Physics	3	1	--	4	30	10	60	--	--	100	4
BSC	SHU122	Calculus and Linear Algebra	3	1	--	4	30	10	60	--	--	100	4
ESC	EEU121	Basic Electrical Engineering	3	--	--	3	30	10	60	--	--	100	3
ESC	CEU121	Engineering Mechanics	3	--	-	3	30	10	60	--	--	100	3
HSMC	SHU123	English	2	--	--	2	--	--	60	--	--	60	2
BSC/LC	SHU124	Physics Lab	--	--	2	2	--	--	--	50	--	50	1
ESC/LC	EEU122	Basic Electrical Engg Lab	--	--	2	2	--	--	--	50	--	50	1
ESC/LC	CEU122	Engineering Mechanics Lab	--	--	2	2	--	--	--	50	---	50	1
HSMC/LC	SHU125	English Lab	--	--	2	2	--	--	--	50	--	50	1
ESC/LC	MEU121	Workshop Practice I	--	--	2	2	--	--	--	50	--	50	1
		Total	14	2	10	26	120	40	300	250	0	710	21

Semester II

Teaching Scheme							Evaluation Scheme						
Category	Course Code	Course Title	Theory	Tutorial	Practical		Theory			Practical		Total	Credits
			Hrs/week	Hrs/week	Hrs/week	Total	MSE	TA	ESE	ICA	ESE		
BSC	SHU221	Chemistry	4	--	--	4	30	10	60	--	--	100	4
BSC	SHU222	Integral calculus and differential equations	3	1	--	4	30	10	60	--	--	100	4
ESC	CSU221	Programming for Problem solving	3	--	--	3	30	10	60	--	--	100	3
ESC	MEU221	Engineering Graphics	2	--	--	2	30	10	60	--	--	100	2
ESC	MEU222/ ETU221	Basic Mechanical Engineering/ Basic Electronics Engineering	2	--	--	2	30	10	60	---	--	100	2
BSC/LC	SHU223	Chemistry Lab	--	--	2	2	--	--	--	50	--	50	1
ESC/LC	CSU222	Programming for Problem solving Lab	--	--	4	4	--	--	--	50	--	50	2
ESC/LC	MEU223	Engineering Graphics Lab	--	--	4	4	--	--	--	50	--	50	2
ESC/LC	MEU224	Workshop Practice II	--	--	2	2	--	--	--	50	--	50	1
		Total	14	1	12	27	150	50	300	200	--	700	21

TA: Teacher Assessment MSE: Mid Semester Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

MSE Duration: 1.30 Hrs all courses

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Important Note:

MEU222 for only Electrical, Electronics & TC, Computer Science, Information Technology and Instrumentation Engineering branch

ETU221 for only Civil and Mechanical Engineering branch

In Semester I, the students of Civil, Mechanical, Electrical & Instrumentation Engineering shall be offered group A courses, and that of Electronics & TC, Computer Science and Information Technology shall be offered group B courses. In Semester II, vice versa.

In addition following courses are offered

SHU122 and MEU121 for all students in Semester I. SHU222 and MEU224 for all students in Semester II.

MEU222 shall be offered in Semester I for Electronics & TC, Computer Science, Information Technology branch. And it shall be offered in Semester II for Electrical and Instrumentation Engineering branch

ETU221 shall be offered in Semester II for Civil and Mechanical Engineering branch.

There should be direct correspondence of group A and group B courses.

Sr. No.	Group A Courses		Group B Courses	
	Course Code	**Title of Course**	**Course Code**	**Title of Course**
1	SHU121	Physics	SHU221	Chemistry
2	EEU121	Basic Electrical Engineering	CSU221	Programming for Problem solving
3	CEU121	Engineering Mechanics	MEU221	Engineering Graphics
4	SHU123	English	SHU223	Chemistry Lab
5	SHU124	Physics Lab	CSU222	Programming for Problem solving Lab
6	EEU122	Basic Electrical Engineering Lab	MEU223	Engineering Graphics Lab
7	CEU122	Engineering Mechanics Lab		
8	SHU125	English Lab		

Category of Course	Definition	Credits
BSC	Basic Science Courses	**18**
ESC	Engineering Science Courses	**21**
HSMC	Humanities and Social Sciences including Mgt.Courses	**3**
	Total Credits	**42**

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SEM III

Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme						Credits
							Theory			Practical	Total		
			Theory Hrs /week	Tutorial Hrs/week	Practical Hrs/week	Total	MSE	TA	ESE	ICA	ESE		
HSMC	SHU321C *SHU322C	Transform and Statistical methods **Integral Calculus and Probability**	3	1	---	4	30	10	60	-	-	100	4
PCC	EEU321	Transformers and DC Machines	3	--	--	3	30	10	60	-	-	100	3
PCC	EEU322	Electrical Circuit Analysis	3	1	--	4	30	10	60	-	-	100	4
PCC	EEU323	Energy Resources and Generation	3	--	--	3	30	10	60	-	-	100	3
ESC	EEU326	Analog Electronic Circuits	3	--	--	3	30	10	60	-	-	100	3
HSMC	SHU323	Introduction to Constitution of India	1	--	--	0	**30**	**20**	--	--	--	50	0
LC	EEU327	Analog Electronic Circuits Lab	--	--	2	2	-	-		50	-	50	1
LC	EEU324	Electrical Machines – Lab I	--	---	2	2	-	-		50	-	50	1
LC	EEU325	Electrical Circuit Analysis Lab	--	--	2	2				50	-	50	1
	Total		**16**	**2**	**6**	**23**	**180**	**70**	**300**	**150**		**700**	**20**

*** For Direct second year admitted students**

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SEM IV														
Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme						Credits
							Theory			Practical		Total	
			Theory Hrs /week	Tutorial Hrs/week	Practical Hrs/week	Total	MSE	TA	ESE	ICA	ESE		
PCC	EEU421	AC Machines	3	--	--	3	30	10	60	-	-	100	3
PCC	EEU422	Signals & Systems	3	1	--	4	30	10	60	-	-	100	4
PCC	EEU423	Electromagnetic Fields	4	0	--	4	30	10	60	-	-	100	4
ESC	EEU426	Digital Electronics	3	--	--	3	30	10	60	-	-	100	3
SHMC	SHU425	Human Values and Ethics	1	0	0	1	30	20	--	-	-	50	0
LC	EEU424	Electrical Measurement and Instrumentation Lab	2	--	2	4	-	-	-	50	-	50	3
LC	EEU427	Digital Electronics Lab	--	--	2	2	-	-	-	50	-	50	1
LC	EEU425	Electrical Machines Lab II	--	--	2	2	-	-	-	50	-	50	1
SHMC	SHU422	Environmental Studies	1	--	--	1	30	20	--	--	---	50	0
	Total		**17**	**1**	**6**	**24**	**180**	**80**	**240**	**150**	**0-**	**650**	**19**

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SEM V

Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme						Credits
							Theory			Practical		Total	
			Theory Hrs. /week	Tutorial Hrs./week	Practical Hrs./week	Total	MSE	TA	ESE	ICA	ESE		
PCC	EEU521	Power Electronics	3	0-	0-	3	30	10	60	-	-	100	3
PCC	EEU522	Power Systems – Apparatus and Modelling	3	1	--	4	30	10	60	-	-	100	4
PCC	EEU523	Control System	3	--	--	3	30	10	60	-	-	100	3
PCC	EEU524	Microprocessor and Microcontrollers	3	--	--	3	30	10	60	-	-	100	3
SHMC	EEU525	Industrial Organization & Management	3	--	--	3	30	10	60	-	-	100	3
PEC	EEU526	Program Elective – I	3	--	--	3	30	10	60	-	-	100	3
LC	EEU527	Power Electronics Lab	--	--	2	2	-	-	-	25	25	50	1
LC	EEU528	Power Systems – Apparatus and Modelling Lab	--	--	2	2	-	-	-	25	25	50	1
LC	EEU529	Control Systems Lab	--	--	2	2	-	-	-	50	-	50	1
LC	EEU530	Microprocessor and Microcontrollers Lab	---	--	2	2	-	-	-	50	-	50	1
	Total		**18**	**1**	**8**	**27**	**180**	**60**	**360**	**150**	**50**	**800**	**23**

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SEM VI

Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme						Credits
							Theory			Practical		Total	
			Theory Hrs. /week	Tutorial Hrs./week	Practical Hrs./week	Total	MSE	TA	ESE	ICA	ESE		
PCC	EEU621	Power Systems –Operation and Control	3	--	-	3	30	10	60	-	-	100	3
PCC	EEU622	Control System Design	3	1	--	4	30	10	60	-	-	100	4
SHMC	EEU623	Operation Research Techniques	3	1	--	4	30	10	60	-	-	100	4
PEC	EEU624	Program Elective – II	3	--	--	3	30	10	60	-	-	100	3
OEC	EEU633	Open Elective – I	3	--	--	3	30	10	60	-	-	100	3
LC	ETU631	Electronics Design Lab	1	0	4	5	-	-	-	50	50	100	3
LC	EEU626	Power Systems –Operation and Control Lab	--	--	2	2	-	-	-	50	-	50	1
LC	EEU627	Control System Design Lab	--	--	2	2	-	-	-	50	-	50	1
PROJ	EEU628	Minor Project	00	00	2	2	-	-	-	25	25	50	1
	Total		**16**	**2**	**10**	**28**	**150**	**50**	**300**	**175**	**75**	**750**	**23**

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SEM VII													
Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme						Credits
							Theory			Practical		Total	
			Theory Hrs /week	Tutorial Hrs/week	Practical Hrs/week	Total	MSE	TA	ESE	ICA	ESE		
PCC	EEU721	Electrical Drives and Control	3	1	--	3	30	10	60	-	-	100	4
PEC	EEU722	Program Elective - III	3	--	--	3	30	10	60	-	-	100	3
PEC	EEU723	Program Elective - IV	3	--	--	3	30	10	60	-	-	100	3
OEC	EEU733	Open Elective - II	3	--	--	3	30	10	60	-	-	100	3
PEC	EEU725	Program Elective - V	3	--	--	3	30	10	60	-	-	100	3
SHMC	EEU726	Energy Management	3	--	--	3	30	10	60	-	-	100	3
LC	EEU727	Electrical Drives and Control Lab	---	--	--	2	-	-	-	25	25	50	1
	Total		**18**	**1**	**02**	**20**	**180**	**60**	**360**	**175**	**25**	**650**	**20**

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SEM VIII												
Category	**Course Code**	**Name of the Course**	**Teaching Scheme**				**Evaluation Scheme**						**Credits**
							Theory			**Practical**		**Total**	
			Theory Hrs /week	**Tutorial Hrs/week**	**Practical Hrs/week**	**Total**	**MSE**	**TA**	**ESE**	**ICA**	**ESE**		
PEC	EEU821	Program Elective - VI	3	0	0	3	30	10	60	-	-	100	3
PROJ	EEU822	A. Project and Seminar **OR** B. Industry Internship Project	0	0	26	26	-	-	-	200	200	400	14
	Total		**3**	**0**	**26**	**29**	**30**	**10**	**60**	**200**	**100**	**500**	**17**

Program Elective Courses

PE-I	**PE-II**	**PE-III**	**PE-IV**	**PE-V**	**PE-VI**
A) Electrical Machine Design	A) Power system protection	A) EHV AC Transmission	A) Power System Modelling	A) HVDC and FACTS	A) Power System Dynamics and Stability
B) Industrial Electrical Systems	B) Energy Conservation in Electrical Utilities	B) High Voltage Engineering	B) Smart Grid	B) Power Quality Issues and Mitigation	B)Wind and Solar Systems
C) Digital Signal Processing	----	C) AI and Machine Learning	C) Advanced Microprocessors	C) Digital Control System	C)Electrical and Hybrid Vehicles
D) Computer organization	D) Object Oriented Programming	D) Data Structures	D) Algorithms	D)Computer Network	D) Cyber Security
E) Embedded Systems	E) Internet of Things	E) Energy Storage System	E) Power System Transients	E) Power System Planning and Design	E)Advanced Drives

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Open Elective Courses (to be offered by Electrical Engineering department)

Open Elective- I	Open Elective - II
Electromechanical Energy Conversion	**Fundamental of Electrical Drives**
Energy Efficiency in Electrical Utilities	**Electrical Estimating and Costing**

BSC Basic Science Courses
ESC Engineering Science Courses
HSMC Humanities and Social Sciences including Management courses
PCC Professional core courses
PEC Professional Elective courses
OEC Open Elective courses
LC Laboratory course
MC Mandatory courses
SI Summer Industry Internship
PROJ Project

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EEU 121 Basic Electrical Engineering

Teaching Scheme : 03 L Total: 03 **Credit: 03**
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

To make the students aware and understand:

1. Various fundamental theorems to solve basic electrical engineering problems.
2. Concepts of magnetism and electrical machines.
3. Necessity of protection and electrical installation.

DC Circuits

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff's Current and Voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

AC Circuits

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

Magnetic Circuits and Transformers

Basics of magnetic circuits, Magnetic materials, BH characteristics, ideal and practical transformer, losses, regulation and efficiency by direct loading, Auto-transformer, three-phase transformer connections (Star and Delta)

Electrical Machines

Concept of rotating magnetic fields, Construction, working, starting and speed control of three-phase induction motor, Single-phase induction motor and separately excited dc motor. Construction and working of synchronous generators. [No Numericals on Module 4]

Electrical Installations

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Text / Reference Books

(i) D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
(ii) D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
(iii) L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press,2011
(iv) E.Hughes,"Electrical and Electronics Technology", Pearson, 2010.
(v) V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

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Course Outcomes

EEU 121.1 To understand and analyze basic electric and magnetic circuits
EEU 121.2 To study the working principles of electrical machines and power converters.
EEU 121.3 To introduce the components of low voltage electrical installations

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EEU122 Basic Electrical Engineering Lab

Teaching Scheme : 02 P **Total: 02** **Credit: 01**
Evaluation Scheme : 50 ICA **Total Marks: 50**

Course Objectives:

Students will be able to

1. Demonstrate the various laws and theorems of electrical circuits
2. Perform the experiments on electrical machines and able to draw the conclusion from them.
3. Identify various parts of machines and protective devices.

List of experiments/demonstrations:

- Basic safety precautions. Introduction and use of measuring instruments – voltmeter, Ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
- Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope).Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
- Transformers: Observation of the no-load current waveform on an oscilloscope (non-sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics).Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
- Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents).Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
- Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winding - slip ring arrangement) and single-phase induction machine
- Torque Speed Characteristic of separately excited dc motor.
- Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor.Generator operation of an induction machine driven at super- synchronous speed.
- Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
- Demonstration of Components of LT switchgear.

Laboratory Outcomes

EEU 122.1	Get an exposure to common electrical components and their ratings.
EEU 122.2	Make electrical connections by wires of appropriate ratings.
EEU 122.3	Understand the usage of common electrical measuring instruments.
EEU 122.4	Understand the basic characteristics of transformers and electrical machines.

ICA - Internal Continuous Assessment shall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

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SHU321C TRANSFORM AND STATISTICAL METHODS

Teaching Scheme: 04 L **Total: 04** **Total Credits: 04**

Evaluation Scheme: 30MSE+60ESE+10TA **Total Marks: 100**

Course Objectives:

1. To use method of partial differential equations to solve wave equation, heat equations.
2. To equip students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
3. To study probability distributions and their properties.

Partial differential equations: Definition, order, degree, classification, formation of partial differential equation, method of separation of variables, first and second order one dimensional wave equation, heat equation and two dimensional Laplace equation.

Laplace Transform

Bilateral Laplace Transform, Relation between Laplace transform and Fourier transform, Properties of Laplace Transform, properties of unilateral Laplace Transform, Laplace transform of causal periodic signals, Analysis and Characterization of LTI systems using the Laplace Transform, The transfer function and differential equation, Impulse response and Step response, Causality, Stability, Stability of a causal LTI system

Random variables and Probability Distributions

Basic concepts of probability and its properties; Conditional probability and independent events; Random variables, discrete and continuous random variables, Mean and variance of Binomial, Poisson and Normal distributions and applications**.**

Sampling Distributions and Interval of Estimation

Sampling Distributions: t-distribution, Chi-square distribution, Interval of estimation.

Text books:

1. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers,2020, 44th edition.
2. Advanced Engineering Mathematics, H.K.Das, S.Chand & Company Pvt.Ltd,2014.
3. A text book of Engineering Mathematics,N.P. Bali and Manish Goyal, Laxmi Publications, Reprint, 2010.

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Reference books:

1. Advanced Engineering Mathematics,Erwin Kreyszig, 9th Edition, John Wiley & Sons, 2006.
2. Higher Engineering Mathematics, B.V,Ramana,Tata Mc Graw Hill Publishing company Ltd.,New Delhi,2008, 6th edition.
3. A First Course in Probability, S. Ross, 6th Ed., Pearson Education India, 2002.
4. An Introduction to Probability and Statistics,V. K. Rohatgi and A.K. Md. Ehsanes Saleh, 2nd Edition.
5. Applied Statistics and Probability for Engineers , D. C. Montgomery and G.C. Runger, 5th edition, John Wiley & Sons, (2009).
6. Introductory Statistics, P. S. Mann, Wiley Publications, 7th edition (2013).
7. I. N. Sneddon, Elements of Partial Differential Equations, Dover Publications, Inc. Mineola New York.

Course Outcomes:

After the successfully completion of the course the student will able to

1. solve wave equation, heat equation with the knowledge of Partial differential equations.
2. develop techniques of data interpretation.
3. develop problem solving techniques needed to accurately calculate probabilities and describe the properties of discrete and continuous distribution functions.
4. use statistical tests in testing hypotheses on data.

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ELPO/EXTC//INSTRU **(DSY)**

SHU322C INTEGRAL CALCULUS AND PROBABILITY

Teaching Scheme: 03Th+ 01Tut = 04 Total | Total Credits: 04

Evaluation Scheme: 30MSE+60ESE+10TA | Total Marks: 100

Course Objectives:

1. To study method solution of partial differential equations and apply it to solve wave and heat equations.
2. To learn Laplace transform and its properties. Apply it to solve differential equation and to calculate stability of LTI system.
3. To equip students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.

Ordinary differential equations of higher orders

Linear differential equation with constant coefficient, complementary function, particular integral, complete solution; method of variation of parameters.

Integral Calculus

Beta and Gamma functions and their properties; Evaluation of double integrals (Cartesian & polar),change of order of integration.

Partial differential equations

Definition, order, degree, classification, formation of partial differential equation, method of separation of variables, first and second order one dimensional wave equation, heat equation

Laplace Transform

Laplace Transform, Properties of Laplace Transform, Laplace transform of causal periodic signals, Analysis and Characterization of LTI systems using the Laplace Transform, The transfer function and differential equation, Impulse response and Step response,

Random variables and Probability Distributions:

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Basic concepts of probability and its properties; Conditional probability and independent events; Random variables, discrete and continuous random variables, Mean and variance of Binomial, Poisson and Normal distributions and applications**.**

Text books:

4. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers,2020, 44th edition.
5. Advanced Engineering Mathematics, H.K.Das, S.Chand & Company Pvt.Ltd,2014.
6. A text book of Engineering Mathematics,N.P. Bali and Manish Goyal, Laxmi Publications, Reprint, 2010.

Reference books:

4. Advanced Engineering Mathematics,Erwin Kreyszig, 9th Edition, John Wiley & Sons, 2006.
5. Higher Engineering Mathematics, B.V,Ramana,Tata Mc Graw Hill Publishing company Ltd.,New Delhi,2008, 6th edition.
6. A First Course in Probability, S. Ross, 6th Ed., Pearson Education India, 2002.

8. An Introduction to Probability and Statistics,V. K. Rohatgi and A.K. Md. Ehsanes Saleh, 2nd Edition.

9. Applied Statistics and Probability for Engineers , D. C. Montgomery and G.C. Runger, 5th edition, John Wiley & Sons, (2009).

10. Introductory Statistics, P. S. Mann, Wiley Publications, 7th edition (2013).
11. I. N. Sneddon, Elements of Partial Differential Equations, Dover Publications, Inc. Mineola New York.

Course Outcomes:

After the successfully completion of the course the student will able to

1. To solve partial differential equations and also to solve wave and heat equations.
2. To use knowledge of Laplace Transform and to solve differential equation and to calculate stability of LTI system.
3. Tackle problems related to continuous and discrete probability distributions.

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EEU321 Transformers and DC Machines

Teaching Scheme	**: 03 L Total: 03**	**Credit: 03**
Evaluation Scheme	**: 30 MSE +10 TA+ 60 ESE**	**Total Marks: 100**
Duration of ESE	**: 2 Hrs.30 min.**	

Course Objectives:

To make students aware and understand

1. Basic concept of Electromagnetic force and torque
2. Construction, Operation and testing of of dc machines
3. Operation and testing of transformers (single and three phase)

Electromagnetic Force and Torque

B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency

DC Machines

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

DC Machine - Motoring and Generation

Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

Transformers

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers No-loadand on -load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Text / References:

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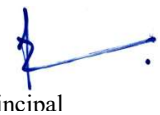

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1. A. E. Fitzgerald and C. Kingsley,"Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines",CBS Publishers,2002.
4. P. S. Bimbhra, "Electrical Machinery",Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU 321.1	Know the concepts of Electromagnetic force and torque.
EEU 321.2	Understand the operation of dc machines.
EEU 321.3	Evaluate the differences in operation of different dc machine configurations.
EEU321.4	Investigate the performance of dc machines and transformer by testing
EEU 321.5	Analyze single phase and three phase transformers circuits and connections

CO-PO-PSO Mapping: (3 High, 2 Medium and 1 Low)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU321.1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
EEU321.2	2	3	1	2	--	-	-	-	-	-	-	-	3	-	-
EEU321.3	3	2	1	2	--	-	-	-	-	-	-	-	2	-	-
EEU321.4	3	2	1	-	-	-	1	-	-	-	-	-	3	-	-
EEU321.5	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-

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EEU322 Electrical Circuit Analysis

Teaching Scheme	**: 03 L + 01 T Total: 04**	**Credit: 04**
Evaluation Scheme	**: 30 MSE +10 TA+ 60 ESE**	**Total Marks: 100**
Duration of ESE	**: 2 Hrs.30 min.**	

Course Objectives:

To make students aware and understand to

1. Analyze electrical network problems.
2. Determine transient and steady state behavior of the electrical networks.
3. Estimate the parameters of two port networks.

Network Theorems

Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks.

Solution of First and Second order networks

Solution of first and second order differential equations for Series and parallel R-L, R-C, R- L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Sinusoidal steady state analysis

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

Electrical Circuit Analysis Using Laplace Transforms

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances

Two Port Network and Network Functions

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

Text / References:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2 D. Roy Choudhury,"Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, " Engineering Circuit Analysis", McGraw Hill Education, 2013.
4 C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.
6. Circuit and Network Analysis By Sudhakar Shyammohan Tata Mc Graw Hill 2005

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Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU 322.1	Apply network theorems for the analysis of electrical circuits.
EEU 322.2	Obtain the transient and steady-state response of electrical circuits.
EEU 322.3	Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
EEU 322.4	Analyse two port circuit behavior.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU322.1	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU322.2	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU322.3	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU322.4	2	-	-	-	-	1	2	-	-	-	-	-	1	-	-

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EEU323 Energy Resources and Generation

Teaching Scheme : 03 L **Total: 03** **Credit: 03**
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:
To make students aware and understand

1. The Challenges of using sources of energy efficiently and effectively
2. The energy conversion systems for various power plants
3. The importance and relevance of renewable energy sources

Thermal and Hydro Power plant
Selection of site, working of various parts: Economizer, air preheater, condenser, cooling tower, coal handling system, ash handling system, Classification of hydro power plant according to available head, nature of load, functions of different components and their working.

Nuclear and Diesel Power plant:

Methods of producing nuclear reactions, functions of different components of nuclear plant, functions of different components of diesel plant.

Solar Energy and its measurement
Solar constants, solar radiation at earth's surface, solar radiation geometry, solar radiation measurement, estimation of average solar radiation, solar radiation on tilted surface, principle of solar energy conversion in to heat, flat plate collectors, energy balance equation and collector efficiency.

Fuel cells
Chemistry applied to fuel cells, principle and operation, classification and types of fuel cells, performance characteristics of fuel cells, classification of fuel cells system.

Wind Energy
Basic principle of wind energy conversion, wind data and energy estimation, selection of site, basic components of wind energy conversion system (WECS), classification of WEC systems, generating system, energy storage, and application of wind energy.

Ocean and Tidal energy
Ocean energy resources, ocean energy routes, ocean thermal energy conversion, progressive wave, wave data collection, Basic principle of tidal power, components of tidal power plants, operation methods of utilization of tidal energy, estimation of power and energy in simple single basin tidal system.

Other Renewable energy resources
Operating principle of energy from biomass. Energy from biogas, geothermal energy. MHD power generation, energy from urban and rural waste, mini and micro hydroelectric power generation.

Expert lectures from experienced persons shall be arranged on above topics if required.

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Text/ References:

1. Conventional Energy Technology, S.B.Pandya, Tata Mc-GrawHill 2005.
2. Non Conventional Energy Resources, G.D.Rai, Khanna Publishers 2001.
3. Energy and Atmosphere, I.M.Campbell, Wiley, New York, 2006.
4. Solar Energy, S.P.Sukhatme, Tata Mc-Graw Hill, 2006.
5. Non Conventional Energy Resourses, B.H.Khan, Tata Mc-Graw Hill, 2003.
6. http://www.nptel.iitm.ac.in/ 5. www.ocw.mit.edu

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU323.1. List and generally explain the main sources of energy and their primary applications nationally and internationally

EEU323.2. Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.

EEU323.3. Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the impact on the environment

EEU323.4. Understand the basic physics of wind and solar power generation.

EEU323.5. Understand the issues related to the grid-integration of solar and wind energy systems.

CO-PO-PSO Mapping: (3 High, 2 Medium and 1 Low)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU323.1	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU323.2	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU323.3	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU323.4	2	-	-	-	-	1	2	-	-	-	-	-	1	-	-
EEU323.5	2	-	-	-	1	1	2	-	-	-	-	-	2	-	-

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EEU326 Analog Electronic Circuits

Teaching Scheme	**: 03 L Total: 03**	**Credit: 03**
Evaluation Scheme	**: 30 MSE +10 TA+ 60 ESE**	**Total Marks: 100**
Duration of ESE	**: 2 Hrs.30 min.**	

Course Objectives:

The subject aims to provide the student with:

1. To study the various electronic circuits using Diode, Transistor and Mosfet
2. To understand the working of various Differential, multi-stage amplifiers
3. Study OpAmp and its application.

Diode circuits

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

BJT circuits

Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits

MOSFET circuits

MOSFET structure and I-V characteristics.MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Module 4: Differential, multi-stage and operational amplifiers (8 Hours)

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Linear applications of op-amp

Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift).Analog to Digital Conversion.

Nonlinear applications of op-amp

Hysteretic Comparator,Zero Crossing Detector, Square-wave and triangular-wave generators.Precision rectifier, peak detector.Monoshot.

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Text/Reference:

1. A. S. Sedra and K. C. Smith, "Microelectronic Circuits", New York, Oxford University Press, 1998.
2. J.V.Wait, L.P.Huelsman and G.A.Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
5. P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog IntegratedCircuits"John Wiley & Sons, 2001.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU 326.1 Understand the characteristics of transistors.

EEU 326.2 Design and analyse various rectifier and amplifier circuits.

EEU 326.3 Design sinusoidal and non-sinusoidal oscillators.

EEU 326.4 Understand the functioning of OP-AMP and design OP-AMP based circuits

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU326.1	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU326.2	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU326.3	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU326.4	2	-	-	-	-	1	2	-	-	-	-	-	1	-	-

SHU 323 INTRODUCTIONS TO CONSTITUTION OF INDIA

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Teaching Scheme: 1 Th **Credit:00**
Evaluation scheme: 20 TA+ 30 MSE **Total Marks:50**
ESE Duration: 1Hr30 Min.

Course Objectives:

To acquaint students about constitution of India, Fundamental rights, fundamental duties, electoral process and role of central, state, and local government and its administration.

Course Content

Unit I:Introduction to Constitution of India
Salient features of the Constitution ofIndia, Preamble of the Constitution, fundamentalrights and fundamentalduties, Directive Principles of State Policy, and relevance of directive principles. Parliamentary Form of Government in India- President, Vice-President, Prime Minister along with council of Minister,Parliament,Supreme court,Electoral process in India.Amendment Procedure.

Unit II: State executivesGovernor, chief minister, state legislature, high courts of state,

Unit III: Role and functions of local self government- Municipalities in India, with special reference to 73rd amendment. Panchayat Raj in India with special reference to 74th amendment.

Course outcomes:

On the successful completion of this course, Students shall be able to-

1. Understand and remember the knowledge of basic information about Indian Constitution.
2. Apply the knowledge of fundamental rights and fundamental duties.

Reference Books: -

1. An Introduction to Constitution of India, M.V.Pylee, Vikas Publishing, 2002
2. Constitution of India, Dr. B. R. Ambedkar, Government of India Publication
3. Latest Publications of Indian Institute of Human Rights, New Delhi

EEU327 Analog Electronic Circuits Lab

Member Secretary Chairman, BoS Principal

Teaching Scheme	**: 02 P**	**Total: 02**	**Credit: 01**
Evaluation Scheme	**: 50 ICA**		**Total Marks: 50**

Course Objectives:
To make students aware and understand to

1. Design, build, test and analyze performance of various electronic circuits using Diode, Transistor and FET
2. Have experience of design and implementation of various amplifiers
3. Analyze and design various applications of OP-AMP

Minimum eight hands-on experiments related to the course contents of ETU Analog Electronic Circuits **shall be performed. The representative list of experiment is as follows.**

1. To study and compare V-I characteristics of PN- junction diode and Zener diode.
2. To Study of diode as clipper and clamper.
3. To study half wave & full wave rectifier without filter and to calculate its ripple factor
4. To study bridge full wave rectifier without filter and to calculate its ripple factor.
5. To study half wave & full wave rectifier with filter and to calculate its ripple factor
6. To study bridge full wave rectifier with filter and to calculate its ripple factor.
7. To study the input and output characteristics of a given transistor in CE configuration.
8. To Study of CE amplifier- current & power gains and input, output impedances.
9. To study biasing of transistor by following method:

a. Fixed bias. b. Voltage divider bias.

10. To study the frequency response of RC coupled amplifier.
11. Measurement and study of output characteristics of JFET.
12. Measurement and study of output characteristics of MOSFET.
13. To study Hartley oscillator.
14. To study the different types of negative feedback in two stage amplifier and to observe its effects upon the amplifier parameters.
15To study biasing of transistor by following method:

a. Fixed bias. b. Voltage divider bias.

Course Outcomes:
After completion of the course, the students will be able to –

EEU 327.1 Set up a bias point in a transistor.
EEU 327.2 Verify the working of diodes, transistors and their applications.
EEU 327.3 Build a common emitter/base/collector amplifier and measure its voltage gain.
EEU 327.4 Explore the operation and advantages of feedback amplifiers.
EEU 327.5 Learn to design different types of filters and apply the same to oscillators and amplifiers.

ICA - Internal Continuous Assessment shall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

EEU324 Electrical Machines – Lab I

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Teaching Scheme : 02 P **Total: 02** **Credit: 01**
Evaluation Scheme : 50 ICA **Total Marks: 50**

Course Objectives:

To make the students aware and understand:

1. Various parts of d.c. machine and transformer
2. Operation and performance of dc motors
3. Testing of dc machines and transformers

Minimum Eight hands-on experiments related to the course contents of EEU321 Transformer and DC Machines to be performed. Representative list is as follows,

1. To identify and understand the functions of various parts of d.c. machines
2. To plot the OCC of d.c. generator
3. To find the critical speed of the d.c. generator
4. To perform and verify the speed control method of d.c. shunt motor
5. To perform the Swinburn test on d.c. machine
6. To perform the load test on d.c. series generator
7. To perform the load test on d.c. series motor
8. To perform the load test on d.c. shunt generator
9. To perform the load test on d.c. shunt motor
10. To perform the load test on d.c. compound generator
11. To perform the load test on d.c. compound motor
12. To perform the test/tests on d.c. machine to separate the losses at constant speed
13. To perform the Hopkinson's Test on d.c. machines
14. To perform the Field test on the d.c. machines
15. To perform the Sumpner's Test on single phase transformer
16. To identify and understand the functions of various parts of the three phase transformer
17. To perform the OC and SC test on three phase transformer
18. To perform the direct loading test on three phase transformer
19. To perform the various connections of three phase transformer
20. To study the scott connection of transformer
21. To perform OC and SC test on single phase transformer

Course Outcomes:

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

EEU 324.1 Identify and understand the functions of various parts of d.c. machines
EEU 324.2 Plot various characteristics of dc machines
EEU 324.3 Test dc machines and transformers

CO-PO-PSO Mapping: (3 High, 2 Medium and 1 Low)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU324.1	2	-	-	-	-	-	-	1	2	-	-	-	2	1	1
EEU324.2	2	-	-	-	-	-	-	1	2	-	-	-	2	1	1
EEU324.3	2	2	-	-	-	-	-	1	2	-	-	-	2	1	1

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EEU325 Electrical Circuit Analysis Lab

Teaching Scheme : 02 P Total 02 **Credit: 01**
Evaluation Scheme : 50 ICA **Total Marks: 50**

Course Objectives:

To make the students aware and understand:

1. Various electrical circuit theorems.
2. Two port network parameters.
3. Steady state response of electrical circuits.

Minimum Eight Hands-on experiments related to the course contents of EEU322 Electrical Circuit Analysis to be performed.. Representative list is as follows.

1. To find self inductance of two coils, mutual inductance between the coils and coefficient of coupling.
2. To verify Maximum Power Transfer theorem.
3. To verify Compensation theorem.
4. To verify Tellegen's theorem.
5. To find Z parameters of two, two port networks connected in series.
6. To find Y parameters of two, two port networks connected in parallel.
7. To determine ABCD parameters of given two port network
8. To find transmission parameters of two, two port networks connected in cascade.
9. To study the response of RL series circuit to sinusoidal input and dc input (using MATLAB).
10. To study the response of RC series circuit to sinusoidal input and dc input (using MATLAB).

Course Outcomes :

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

EEU 325.1 Contruct simple electrical circuits using suitable elements
EEU 325.2 Perform experimnts for verification of various facts and principles
EEU 325.3 Derive conclusions on the basis of the readings/ observations

ICA - Internal Continuous Assessment shall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

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EEU421 AC Machines

Teaching Scheme : 03 L Total: 03 **Credit: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

To make students aware and understand

1. Basic concept of AC machine winding and revolving magnetic field
2. Operation and testing of Induction machine (single and three phase)
3. Construction , Operation and testing of synchronous machines

Fundamentals of AC Machine Windings

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

Pulsating and Revolving Magnetic Fields

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Induction Machines

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Single-Phase Induction Motors

Constructional features double revolving field theory, equivalent circuit, and determination of parameters. Split-phase starting methods and applications

Synchronous Machines

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

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3. P. S. Bimbhra, “Electrical Machinery”,Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
5. A. S. Langsdorf, “Alternating current machines”,McGraw Hill Education, 1984.
6. P. C. Sen “ Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU 421.1	Know the different windings in ac machines
EEU421.2	Understand the concepts of rotating and pulsating magnetic fields.
EEU 421.3	Understand constructional details of ac machines
EEU 421.4	Investigate the performance of ac machines.
EEU421.5	Evaluate the steady state behavior and operating characteristics of AC machines.

CO-PO-PSO Mapping: (3 High, 2 Medium and 1 Low)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU421.1	2	-	-	-	-	-	-	-	-	-	-	-	1	1	-
EEU421.2	2	3	-	2	-	-	-	-	-	-	-	-	2	1	-
EEU421.3	3	2	1	1	-	-	-	-	-	-	-	-	2	2	-
EEU421.4	2	2	-	1	-	-	-	-	-	-	-	-	2	1	-
EEU421.5	3	2	1	-	-	-	1	-	-	-	-	-	2	2	-

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EEU422 Signals and Systems

Teaching Scheme : 03 L + 01 T Total: 04 Credit: 04
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

1. Understand the concepts of continuous time and discrete time systems.
2. Able to find output of LTI system by convolution.
3. Analyse LTI systems in frequency domain

Introduction to Signals and Systems

Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Behavior of continuous and discrete-time LTI systems Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Fourier, Laplace and z- Transforms

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Sampling and Reconstruction

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Text/References:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson, 2006.

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3. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 2009.
6. M. J. Robert "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.
7. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2009.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU 422.1	Understand the concepts of continuous time and discrete time systems.
EEU 422.2	Analyse systems in complex frequency domain.
EEU 422.3	Understand sampling theorem and its implications.

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EEU423 Electromagnetic Fields

Teaching Scheme : 04 L Total: 04 **Credit: 04**
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

To make the students aware and understand:

1. Electrostatic boundary-value problems.
2. The types and properties of magnetic materials.
3. The concept of static and time varying fields.

Note:-This course shall have Lectures and Tutorials. Most of the students find difficult to visualize electric and magnetic fields. Instructors may demonstrate various simulation tools to visualize electric and magnetic fields in practical devices like transformers, transmission lines and machines.

Review of Vector Calculus

Vectoralgebra-addition,subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vectorcalculus- differentiation, partial differentiation,integration,vector operator del, gradient, divergence and curl;integraltheoremsofvectors. Conversion of a vector from one coordinatesystem toanother.

Static Electric Field

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density

Conductors, Dielectrics and Capacitance

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Static Magnetic Fields

Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Magnetic Forces, Materials and Inductance

Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

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Time Varying Fields and Maxwell's Equations

Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.

Text /

References:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
4. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
5. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
6. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.
7. E. G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press, 1966.
8. B. D. Popovic, "Introductory Engineering Electromagnetics",Addison-Wesley Educational Publishers, International Edition, 1971.
9. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012.

Course outcomes:

At the end of the course, students will demonstrate the ability

EEU 423.1	To understand the basic laws of electromagnetism.
EEU 423.2	To obtain the electric and magnetic fields for simple configurations under static conditions.
EEU 423.3	To analyse time varying electric and magnetic fields.
EEU 423.4	To understand Maxwell's equation in different forms and different media.
EEU 423.5	To understand the propagation of EM waves.

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EEU426 Digital Electronics

Teaching Scheme : 03 L Total: 03 **Credit: 03**
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

1. To acquire the basic knowledge of digital logic circuit components
2. To understand and analyze and design combinational logic circuits using gates and MSIs
3. To design and realize combinational and sequential digital electronic circuits

Fundamentals of Digital Systems and logicfamilies

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples ofICgates, number systems-binary, signed binary, octal hexadecimal number, binaryarithmetic,one's and two's complements arithmetic, codes, error detecting and correctingcodes,characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-statelogic.

Combinational DigitalCircuits

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer,De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder,serialadder, ALU, elementary ALU design, popular MSI chips, digital comparator,paritychecker/generator, code converters, priority encoders, decoders/drivers for display devices,Q-M method of functionrealization.

Sequential circuits and systems

A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-TandD-types flipflops, applicationsof flipflops, shiftregisters, applications of shift registers, serialtoparal lel converter, parallel to serial converter, ring counter, sequence generator,ripple(Asynchronous) counters, synchronous counters, counters design using flip flops,specialcounter IC's, asynchronous sequential counters, applications ofcounters.

Module 4: A/D and D/A Converters (7Hours)

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/Aconverter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit,analog to digital converters: quantization and encoding, parallel comparator A/Dconverter,successive approximation A/D converter, countingA/D converter, dual slope A/Dconverter, A/Dconverter using voltage to frequency and voltage to time conversion, specificationsofA/Dconverters, example of A/D converterICs

Module 5: Semiconductor memories and Programmable logic devices. (7Hours)

Memory organization and operation, expanding memory size,classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

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Text/References:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

CourseOutcomes:

At the end of this course, students will demonstrate the ability to

EEU 426.1	Understand working of logic families and logic gates.
EEU 426.2	Design and implement Combinational and Sequential logiccircuits.
EEU 426.3	Understand the process of Analog to Digital conversion and Digital to Analog conversion.
EEU 426.4	Be able to use PLDs to implement the given logical problem.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU426.1	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU426.2	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU426.3	2	-	-	-	1	1	1	-	-	-	-	-	1	-	-
EEU426.4	2	-	-	-	-	1	2	-	-	-	-	-	1	-	-

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SHU 325/425/525/725 HUMAN VALUES AND ETHICS

Teaching Scheme: 1 Th **Credit: 00**
Evaluation scheme: 20 TA+ 30 MSE **Total Marks: 50**
ESE Duration: 1Hr 30 Min.

Objectives:

1. To develop the importance of moral virtue through spiritual and yoga activities which leads to professional experience of students.
2. To understand the dimension of professional ethics.
3. To learn engineering ethics through theories which develop moral judgment among technical students.
4. To understand the global ethical issues and its dimension which leads to moral leadership.

Human Values

Morals, values and Ethics, Integrity, Work ethic, Service learning, Civic virtue, Harmony- Human Harmony, Nature Harmony, Harmony in Society, Honesty, Courage, Valuing time, Self-confidence, Character, Spirituality, Introduction to yoga and meditation for professional excellence and stress management.

Professional Ethics

Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Professional Ethics; Principles of Professional Ethics Conflict of Interest, Gift Vs Bribery, Attendance Vs Punctuality,

Engineering Ethics

Senses of 'Engineering Ethics', Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles.

Global Issues

Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisors, Moral Leadership, Code of Conduct, Corporate Social Responsibility

Text books:

1. Ethics in Engineering, Mike W. Martin and Roland Schinzinger, Tata McGraw Hill, New Delhi, 2003.
2. Engineering Ethics, Govindarajan M, Natarajan S, Senthil Kumar V. S, Prentice Hall of India, New Delhi, 2004.

Reference books:

1. Engineering Ethics, Charles B. Fleddermann, Pearson Prentice Hall, New Jersey,

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2004.
3. Engineering Ethics – Concepts and Cases, Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, Cengage Learning, 2009
4. Ethics and the Conduct of Business, John R Boatright, Pearson Education, New Delhi,2003
5. Fundametals of Ethics for Scientists and Engineers, Edmund G Seebauer and Robert L Barry, Oxford University Press, Oxford, 2001
6. Business Ethics: Decision Making for Personal Integrity and Social Responsibility, Laura P. Hartman and Joe Desjardins, McGraw Hill education, India Pvt.Ltd.,New Delhi 2013.
7. Value Education, World Community Service Centre, Vethathiri publications, Erode, 2011

Outcomes:
After the successful completion of the course the student shall be able to

1. Make work life balance and found himself or herself with sound mindset at workplace.
2. Incorporate professional ethics at work place.
3. Manage moral dilemmas and conflicts at workplace.
4. Develop global perspective for ethical issues.

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EEU424 Electrical Measurement and Instrumentation Lab

Teaching Scheme : 02 L + 02 P **Total 04** **Credit: 03**
Evaluation Scheme : 50 ICA **Total Marks: 50**

Course Objectives:
To make the students aware and understand:

1. Different bridges and their applications.
2. Different transducers and their working principles.
3. Measurement of non-electrical parameters like pressure, force, velocity etc.

Lectures/Demonstrations:

1. Concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.
2. Errors in Measurements. Basic statistical analysis applied to measurements: Mean, Standard Deviation, Six-sigma estimation, C_p, C_{pk}.
3. Sensors and Transducers for physical parameters: temperature, pressure, torque, flow.Speed and Position Sensors.
4. Current and Voltage Measurements. Shunts, Potential Dividers,.Instrument Transformers, Hall Sensors.
5. Measurements of R, L and C.
6. Digital Multi-meter, True RMS meters, Clamp-on meters, Meggers.
7. Digital Storage Oscilloscope.

Experiments

1. Measurement of a batch of resistors and estimating statistical parameters.
2. Measurement of L using a bridge technique as well as LCR meter.
3. Measurement of C using a bridge technique as well as LCR meter.
4. Measurement of Low Resistance using Kelvin's double bridge.
5. Measurement of High resistance and Insulation resistance using Megger.
6. Usage of DSO for steady state periodic waveforms produced by a function generator.
   Selection of trigger source and trigger level, selection of time-scale and voltage scale.Bandwidth of measurement and sampling rate.
7. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
8. Usage of DSO to capture transients like a step change in R-L-C circuit.
9. Current Measurement using Shunt, CT, and Hall Sensor.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU 424.1	Design and validate DC and AC bridges.
EEU 424.2	Analyze the dynamic response and the calibration of few instruments.
EEU 424.3	Learn about various measurement devices, their characteristics, their operation and their limitations.
EEU 424.4	Understand statistical data analysis.
EEU 424.5	Understand computerized data acquisition.

ICA - Internal Continuous Assessment shall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

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EEU427 Digital Electronics Lab

Teaching Scheme : 02 P Total: 02 Credit: 01
Evaluation Scheme : 50 ICA Total Marks: 50

Course Objectives:

1. To acquire the hands-on experience of digital component, circuit realization using bread board
2. To realize combinational logic circuits using Logic gates and MSIs
3. To realize sequential circuits using gates, FF and MSIs

Minimum Eight hands-on experiments related to the course contents of ETU Digital Electronics to be performed. Representative list is as follows,

1. To verify truth table of different logic gates.
2. NOR gate as universal gate: Realization of AND/ OR/ NAND/ NOT/ EX-OR gates using NOR gates only
3. NAND gate as universal gate: Realization of AND/ OR/ NOR / NOT/ EX-OR gates using NAND gates only
4. Realization of half adder using gates
5. Realization of half subtractor using gates
6. Implementation of full Adder circuit using gates
7. To study Flip-Flops (Realization of RS/ T/ D/ JKMS flip-flops using logic gates)
8. To study counters: Up counter/ down counter/ up-down counter/ decade counter
9. To study shift registers: Left shift/ right shift register
10. To study analog to digital converter
11. To study digital to analog converter

Course Outcomes :

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

EEU 427.1 Analyze and design simple logic circuits using gates
EEU 427.2 Construct the circuits for experiments and take readings/ observations
EEU 427.3 Derive conclusions on the basis of the readings/ observations in context of digital electronics
EEU 427.4 Explain the working principle of various combinational and sequential logic circuits
EEU 427.5 Explain the working principle of ADC and DAC

Note:

ICA - Internal Continuous Assessment shall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

ESE - The End Semester Exam for practical shall be based on performance in one of experiments and may be followed by sample questions.

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EEU425 Electrical Machines Lab II

Teaching Scheme	**: 02 P**	**Total: 02**	**Credit: 01**
Evaluation Scheme	**: 50 ICA**		**Total Marks: 50**

Course Objectives:

Minimum Eight Hands-on experiments related to the course contents of EEU 421 Electrical Machines - II to be performed. Representative list is as follows

1) To Determine the regulation of three phase Alternator by direct loading method
2) To determine the regulation of three phase Alternator by Synchronous Impedance Method
3) To find Xd and Xq of salient pole synchronous machine by slip test
4) To study starting and reversal of direction of rotation of three phase synchronous motor
5) To plot the 'V' and 'Inverted V' curves of synchronous motor
6) Application of synchronous motor as power factor correction device
7) To perform the load test on three phase induction motor and plot its characteristics
8) Perform the No load and short circuit test on three phase Induction motor to find its Equivalent circuit
9) Construction of Circle diagram from the No load and short circuit test Data
10) Speed control of three phase induction motor
11) Study of three phase induction motor starters
12) Running light and locked rotor test on single phase induction motor to find its equivalent circuit.
13) Parallel operation of Alternators (Synchronizing Methods)

Course Outcomes

At the end of the course, students will be able to

1) Identify and understand the functions of various parts of alternators
2) Plot various characteristics of alternators
3) Start and operate induction motor according to requirement
4) Test induction motors

Note:-

ICA - Internal Continuous Assessment shall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

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SHU 422 ENVIRONMENTAL STUDIES

Teaching Scheme: 1 Th **Credit: 00**
Evaluation scheme: 20 TA+30 MSE **Total Marks: 50**
ESE Duration: 1Hr30 Min.

Course objectives: The objectives of offering this course are to-

- Be aware of various environmental factors and there preservation.
- Teach them how to protect Environment and natural resources.
- How to make equitable use of energy resources.

Course Content

The Multidisciplinary Nature of Environmental Studies: Definition, scope and importance, Need for public awareness.

Social issues and Environment: From Unsustainable to sustainable development, urban problems related to energy, Water conservation, rainwater harvesting, and watershed management Resettlement and rehabilitation of people, problems.
Environmental ethics: Issues and possible solution, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation. Consumerism and Waste products, Environment protection act, Air (prevention & control) act, Water (prevention and control) act, Wildlife protection act, Forest conservation act, Issues involved in enforcement of environmental legislation.
Human population and environment: Environment and human health, Human rights, Role of Information Technology in Environment and human health, Public awareness.

Natural Recourses: Conventional energy resources: definition, classification, composition, energy content types: coal, petroleum, natural gases, hydrogeothermal, nuclear, environmental implication of energy uses. Non conventional energy resources: solar energy, wind energy, tidal energy, geothermal energy, hydropowers and biogas.

Ecosystem and Biodiversity: Concept of ecosystem, Structure and function of ecosystem, Producer, consumer, decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of following ecosystem: Forest ecosystem, Grass land ecosystem, Desert ecosystem Aquatic ecosystem(Rivers and ocean).
Introduction- definition: genetics, species and ecosystem, diversity.
Biogeographically classification of India. Conservation of biodiversity- In-situ and Ex-situ conservation of Biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Endangered and endemic species of India. Value of biodiversity:

consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local level. India as mega diversity nation. Hot spot of biodiversity.

Environmental Pollution: Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste, Management, Causes effects and control measures, Role of individual in prevention of pollution, Hazardous waste management, Biomedical waste management, Disaster management: floods, earthquake, cyclone and landslides.

Course outcomes: After studying the course, the students will be able to:-

- Convey the Environmental awareness among peoples.
- Apply Conservation of various natural resources and environmental factors.
- Awareabout social and environmental issues.

Recommended Books:

1) The Biodiversity of India, Bharucha Erach ,Marin Publishing Pvt. Ltd., Ahmedabad
2) Brunner R.C., 1989,Hazardous Waste Incineration, McGraw Hill Inc.
3) Marine pollution, Clark R.S., Clanderson Press Oxford (TB)
4) Environmental Chemistry, De A.K. Wiley EsternLmt.
5) Environmental Chemistry, Sharma B.K., 2001 Goel Publ., House, Meerat.
6) Environmental Management, Wagner K.D., 1998, W.B. Saunders Co., Philadelphia, USA
7) Environmental Studies, Benny Joseph, 1st edition,2005,TataMcgraw-Hill Publ.

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EEU521 POWERELECTRONICS

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Role of Power Electronics in control and conversion of Electrical power
II. Analysis of all power converters
III. PWM converters, Switched mode converters and UPS system.

Thyristor family devices: Structure, Characteristics, Switching actions, Trigger requirements, Ratings, Protections and applications of SCR, TRIAC and DIAC.

Modern Power Devices: Structure, Characteristics, Switching actions, Trigger requirements, Protections and Applications of GTO,IGBT, Power MOSFET and MCT. Introduction to Power Integrated Circuits and Silicon Carbide (SiC) Power Devices

AC-DC and AC/DC Converters (Controlled Rectifiers): Single phase half controlled (semi- converter) and fully controlled converters - Quadrants of operation, circuit configurations, working, performance parameters and input-output wave forms for R and R-L loads, continuous and discontinuous current conduction, effect of freewheeling diode. Single phase dual converter in circulating and non-circulating current modes.

DC-DC Converters (DC Choppers): Step-up and step-down configurations, CLC and TRC techniques, PWM and FM techniques. Practical thyristorized and transistorized chopper circuit- working, control, commutation, waveforms, continuous and discontinuous current conduction.

DC-AC Converters (Inverters): VSI and CSI. PWM techniques-Single, Multiple and Sinusoidal PWM. Transistorized(PWM) Inverters-Principle of operation, performance parameters and working of single phase and threephase circuits.

PWM PWM Converters: Principle of operation, circuit configuration s and applications of Switched Mode Converters (buck, boost and buck-boost) and Switched ModeRectifiers.
Principle of cyclo converter, single phase to single phase cyclo converter circuit. Single phase AC regulators with R and R-L loads, Power factor corrector circuits, Introduction to UPSsystems.

Text Books:

1. Power Electronics-Circuits Devices and Application, M. H. Rashid 2nd Ed, Prentice Hall of India (PHI) Pvt. Ltd., New Delhi, 2003.
2. Power Electronics – Converters, Applications and Design, Mohan, Undemand, Robbins,3rd. Ed,JohnWilley&Sons, 2004

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Reference Books:

1. SCR Manual, General Electric, 6th Ed,1990.
2. Modern Power Devices, B. J.Baliga, John Willey,1992.
3. Power Electronics Principles and Applications, Joseph Vithayathil, Tata MCGraw-Hill Edition, 2010
4. Power Electronics–Devices, Driversand Applications,B.W.Williams,John Wiley,2005
5. Power Electronics, K Thorborg, PHI Int.Ltd, 1988.
6. http://www.nptel.iitm.ac.in
7. www.ocw.mit.edu

Course Outcomes:

On completion of the course, students will be able to:

EEU722A.1 Classify different types of Power Semiconductor Switches.

EEU722A.2 Evaluate V-I characteristics, turn-on and turn-off methods for different power semiconductor devices.

EEU722A.3 Compare different types of Power Converters with their operational and analytical details.

EEU722A.4 Analyse waveforms at the input and output ports of the converters.

EEU722A.5 Understand construction and working of PWM converters, UPS, Power factor corrector circuit etc.

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU522.1	2	0	0	0	0	0	0	0	0	0	0	0	2	1	0
EEU522.2	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0
EEU522.3	3	3	2	2	2	0	0	0	0	0	0	0	2	2	0
EEU522.4	2	3	0	1	2	0	0	0	0	0	0	0	2	2	0
EEU522.5	2	1	0	0	0	0	0	0	0	0	0	0	1	1	0

0- Not correlated 1 - Weakly Correlated 2- Moderately Correlated 3- Strongly Correlated

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EEU522 Power System– Apparatus and Modeling

Teaching Scheme : 03 L **Total: 03** **Credit: 03**
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

At the end of this course, students will be able to

1. Understand the concepts of power system & various power system components.
2. Analyze different faults in power system.
3. Explain the generation of over-voltages and insulation coordination.

Introduction and basic concepts of Power systems

Evolution of power systems, structure of power systems, Power system scenario in India, relevant IS codes, concept of regional and National GRID, overview of conventional and non-conventional power generation. Complex power: Introduction, concept of real, reactive and complex power and their effects on power system operation

Per unit system. Transmission line parameters: Resistance, inductance and capacitance of single phase and three phase line, concept of GMR and GMD, Skin effect, Proximity Effect.

Models and performance of transmission line power system components

Transmission line models - short, medium and long lines, voltage and current waves, surge impedance, loading of transmission line, phenomenon of Corona, complex power flow through transmission lines, power transmission capability, Ferranti effect, methods of voltage control.

Synchronous generators: generator model, steady state characteristics, synchronous machine transients, determination of transient constants, DC component of stator currents.

Fault Analysis and Protection Systems

Method of symmetrical components (positive, negative and zero sequences), Balanced and unbalanced faults, Representation of generators, lines and transformers in sequence networks. Computation of fault currents, Neutral grounding.

Over-voltages and Insulation Requirements

Generation of over-voltages: Lightning and switching surges. Protection against overvoltages, insulation coordination. Propagation of surge, Voltages produced by traveling surges. Travelling-wave equations, Bewley diagrams.

Text/References:

1. . D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003
2. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
3. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.

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Course Outcomes:

At the end of this course, students will demonstrate the ability to

522.1 Get the knowledge of power system and its components, structure, evolution and national level scenario

522.2 Estimate the parameters of transmission line, understand its operation, role and select the model for various studies.

522.3 Be able to model and analyze different power system components in per unit system

522.4 Evaluate symmetrical and unsymmetrical faults on power, compute fault currents and use the information for protection purpose.

522.5 Understand the generation of over-voltages and insulation coordination.

CO-PO-PSO Mapping: (3 High, 2 Medium and 1 Low)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU522.1	2	2	1	1	2	2	2	2	--	1	1	1	2	1	2
EEU522.2	2	1	1	2	2	1	2	1	--	1	1	1	2	1	2
EEU522.3	1	3	1	2	2	1	2	1	--	1	1	1	2	1	2
EEU522.4	1	3	--	2	2	1	1	1	-	1	1	1	2	2	2
EEU522.5	1	1	1	3	2	1	3	3	-	1	1	1	1	1	3

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EEU523 CONTROL SYSTEM

Teaching Scheme	**: 03 L + 01 T Total: 04**	**Credit: 04**
Evaluation Scheme	**: 30 MSE +10 TA+ 60 ESE**	**Total Marks: 100**
Duration of ESE	**: 2 Hrs.30 min.**	

Course Objectives:

To make students aware and understand

1. Role of control system in modernization
2. Analyze the control system in time domain, frequency domain and in state space
3. Investigate the stability of control systems

Introduction to control problem

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

Time Response Analysis

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

Frequency-response analysis

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

State Variable Analysis

State, state space and state variables; SISO/MIMO linear systems state variable models - differential equations, Transfer Functions, Block Diagrams and State Diagrams (Signal Flow Graphs); Transfer functions decomposition - Phase variable forms, Canonical forms and Jordan canonical form; Transfer function - state model; Transfer matrix; State equations solution - State transition matrix (STM); STM Computation – Laplace transformation, Canonical transformation and Cayley Hamilton theorem; Time response – SISO Systems.Concept - controllability and observability; SISO/MIMO Linear systems -Gilbert's method and Kalman's test; SISO controllable systems Design -state feedback.

Text/References:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
3. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
4. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

Course Outcomes:

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

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EEU523.1 Formulate mathematical model of LTI systems using TF and state space representation
EEU523.2 Explore control systems in time domain and frequency domain
EEU523.3 Understand the concept of stability and assessment for LTI systems
EEU523.4 Represent the linear discrete-time systems by State-space models
EEU523.5 Design simple feedback controllers.

CO-PO-PSO Mapping: (3 High, 2 Medium and 1 Low)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU523.1	3	1	1	3	--	--	--	--	--	--	--	--	1	3	--
EEU523.2	3	3	3	2	2	--	--	--	--	--	--	--	2	3	--
EEU523.3	3	3	3	2	2	--	--	--	--	--	--	--	2	3	--
EEU523.4	3	3	1	3	3	--	--	--	--	--	--	--	--	2	--
EEU523.5	3	3	2	3	1	--	--	--	--	--	--	--	--	3	--

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EEU524 MICROPROCESSOR AND MICROCONTROLLERS

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Imparting the knowledge about the complete hardware of the microprocessor and microcontrollers
II. Imparting the knowledge of the software used to develop programs
III. Skills to interface a variety of external devices with microcontrollers

Fundamentals of Microprocessors: Fundamentals of Microprocessor Architecture. 8-bitMicroprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems. Overview of the 8051 family.

The 8051 Architecture: Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.

Instruction Set and Programming: Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing. 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, C language programs. Assemblers and compilers. Programming and debugging tools.

Memory and I/O Interfacing: Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, counters, memory devices.

External Communication Interface and applications: Synchronous and Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee. LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing.

Text Books:


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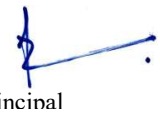
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1. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”,Pearson Education, 2007.
2. K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning,2004.
3. R. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996

Reference Books:

1. R. Kamal, “Embedded System”, McGraw Hill Education,2009.
2. D.A. Patterson and J.H. Hennessy, "Computer Organization and Design: The Hardware/Software interface”, Morgan Kaufman Publishers, 2013
3. D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991

Course Outcomes:

On completion of the course, students will be able to:

EEU524.1 Formulate mathematical model of LTI systems using TF and state space representation

EEU524.2 Explore control systems in time domain and frequency domain

EEU524.3 Understand the concept of stability and assessment for LTI systems

EEU524.4 Represent the linear discrete-time systems by State-space models

EEU524.5 Design simple feedback controllers.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU524.1	2	1	0	0	0	0	0	0	0	0	0	0	1	2	1
EEU524.2	1	1	2	2	1	0	0	0	0	0	0	0	1	2	1
EEU524.3	0	1	1	2	2	0	0	0	0	0	0	1	1	1	1
EEU524.4	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
EEU524.5	0	0	0	2	2	0	0	0	0	0	0	1	2	1	2

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EEU525 INDUSTRIAL ORGANIZATION & MANAGEMENT

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Understand principles of management, marketing and financial management
II. Know Personnel Management
III. Learn estimating and costing

Introduction: Definition and Concept, principles of management, management and administration, functions of management, various areas of management, ownership and types of ownerships, concept of organization structure-types and relationship, centralization, decentralization, delegation of power, span of working.

Marketing Management: Concept, different types of market research, various marketing strategies, types of markets, market segmentation, sales organization structure and responsibilities, advertising media, sales performance objectives, services marketing, Introduction to International marketing decisions, practices and problems of international marketing, import export procedures.

Financial Management: Need for finance, elements of cost, waste and scrap, financial ratios, profit and loss statements, balance sheet, working and fixed capital, different methods of depreciation.

Personnel Management: Functions of Personnel Management, human resources planning, recruitment and training, workers participation in management, collective bargaining, job evaluation and performance appraisal, industrial disputes, industrial safety, labor legislation.

Estimating, Costing and Materials Management: Objectives of estimating and costing, elements of cost, estimating procedure for weights, material costs, machining time, fabrication cost. Classes of materials, purchasing methods and procedure, inventory control, stores, EOQ, ABC analysis.

Text Books:

7. Essentials of Management, Koontz, Harold, McGraw-Hill Education (India) I, New Delhi, 2004.
8. Industrial Engineering and Management, O.P.Khanna, Dhanpa tRai & Sons, 1998.

Reference Books:

1. Inventory Management Chandra Bose, PHI, New Dehli 2005.
2. Industrial Engineering and Management Science, Banga,T.R., Khanna Publishers 1989.
3. Purchasing and Materials Management, Gopalkrishnan, McGraw-Hill Education (India) I, New Delhi, 2001.

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Course Outcomes:

On completion of the course, students will be able to:

EEU525.1	Know principles of management.
EEU525.2	Understand marketingmanagement and financialmanagement
EEU525.3	Understand Personnel Management
EEU525.4	Capable to do estimating and costing of material
EEU525.5	Study of material management

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU525.1	0	0	0	0	0	1	2	2	2	2	0	1	0	1	2
EEU525.2	0	0	0	0	0	1	0	0	3	3	2	1	0	1	2
EEU525.3	0	0	0	0	0	1	1	2	1	2	-	1	0	1	2
EEU525.4	0	0	0	0	0	0	0	0	1	0	2	1	0	0	1
EEU525.5	0	0	0	0	0	0	1	0	1	0	2	1	0	1	1

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EEU526(A) ELECTRICAL MACHINE DESIGN

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Challenges in efficient and cost-effective electrical machine design
II. Design procedures for various electrical machines
III. Computer aided design approach for optimal electrical machine design.

Introduction: Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines

Transformers: Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

Induction Motors: Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

Synchronous Machines: Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design

Computer aided Design (CAD): Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to **c**omplex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Text Books:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.

Reference Books:

1. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
2. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969.

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3. Shanmuga sundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”, New Age International, 1979.
4. K. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications, 2008.
5. Electrical machines and equipment design exercise examples using Ansoft’s Maxwell 2D machine design package.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU526A.1 Understand the construction and performance characteristics of electrical machines.

EEU526A.2 Analyze the effect of various factors which influence the design, electrical, magnetic and thermal loading of electrical machines

EEU526A.3 Apply the principles of electrical machine design and carry out a basic design of electrical machines.

EEU526A.4 Comprehend various approaches for computer aided design of electrical machines.

EEU526A.5 Use software tools to do design calculations.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU526A.1	3	2	3	0	0	0	0	0	0	0	0	0	3	2	0
EU526A.2	3	3	3	2	2	0	1	0	0	0	0	0	3	0	0
EU526A.3	3	3	3	3	2	1	1	0	0	0	0	0	3	3	0
EU526A.4	2	1	2	1	2	0	0	0	1	0	0	0	1	0	0
EU526A.5	3	0	0	0	0	0	0	0	0	0	0	0	2	1	0

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EEU526(B) INDUSTRIAL ELECTRICAL SYSTEMS

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Impart the knowledge about the residential, commercial and industrial electrical installation systems
II. Impart the knowledge for designing the illumination system for residential, commercial and industrial premises
III. Impart the knowledge for designing the automation process

Electrical System Components: LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

Residential and Commercial Electrical Systems: Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Illumination Systems: Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Industrial Electrical Systems I : HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components' Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Industrial Electrical System Automation: Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text Books:

1. S.L. Uppal and G.C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007

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Reference Books:

1. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.
2. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU526B.1 Understand the components of electrical installation.

EEU526B.2 Estimate the electrical wiring systems for residential, and commercial. consumers, representing the systems with standard symbols and drawings, SLD.

EEU526B.3 Designthe illuminationsystems form for residential, commercial and industrial premises.

EEU526B.4 Analyze and selectthe proper size of various electrical system components for industrial electrical installation.

EEU526B.5 Design the process automation for various applications.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU526B.1	2	1	0	0	0	0	0	0	0	0	0	0	1	2	1
EEU526B.2	1	1	2	2	1	0	0	0	0	0	0	0	1	2	1
EEU526B.3	0	1	1	2	3	0	0	0	0	0	0	1	1	1	1
EEU526B.4	0	1	0	2	2	0	0	0	1	0	0	0	1	0	1
EEU526B.5	0	0	0	2	2	0	0	0	0	0	0	1	2	1	2

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EEU526(C) DIGITAL SIGNAL PROCESSING

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Discrete time signal sequences and representation.
II. Z-transform interpretation in DTS.
III. Concept of DFT and filter design technique.

Discrete-time signals and systems : Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

Z-transform: Z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using Z-transform, Properties of Z-transform for causal signals, Interpretation of stability in Z-domain, Inverse Z-transforms.

Discrete Fourier Transform: Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Design of Digital filters: Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signalprocessing.

Applications of Digital Signal Processing: Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text Books:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.

Reference Books:

1. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall, 1997.
2. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall 1992.
3. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
4. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

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5. http://www.nptel.iitm.ac.in/
6. http://www.ocw.mit.edu/

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU526 C.1 Represent signals mathematically in continuous and discrete-time,and in thefrequency domain

EEU526 C.2 Analyze discrete-time systems using z-transform.

EEU526 C.3 Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.

EEU526 C.4 Design digital filters for various applications.

EEU526 C.5 Apply digital signal processing for the analysis of real-life signals.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU526 C.1	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU526 C.2	2	2	2	3	0	0	0	0	0	0	0	0	2	0	0
EEU526 C.3	2	3	2	2	1	0	0	0	0	0	0	0	2	0	0
EEU526 C.4	2	2	2	1	1	0	0	0	0	0	0	0	2	0	0
EEU526 C.5	2	2	1	1	1	0	0	0	0	0	0	0	2	0	0

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EEU526(D) COMPUTER ORGANIZATION

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. How Computer Systems work & the basic principles
II. Instruction Level Architecture and Instruction Execution
III. The current state of art in memory system design

Introduction to computer organization: Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.

Memory organization: System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.

Input – output Organization: Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port.Features of PCI and PCI Express bus.

16 and 32 microprocessors: 80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU andBIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86,I/O addressing in 80x86

Pipelining and different architecture: Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Datahazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence oninstruction set.
VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

Text Books:

1. V. Carl, G. Zvonko and S. G. Zaky, **"**Computer organization**"**, McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, **"**The Intel microprocessors**"**, Pearson Education, 2000.

Reference Books:

1. J. L. Hennessy and D. A. Patterson, **"**Computer Architecture A Quantitative Approach**"**, Morgan Kauffman, 2011.
2. W. Stallings, **"**Computer organization**"**, PHI, 1987.
3. P. Barry and P. Crowley, **"**Modern Embedded Computing**"**, Morgan Kaufmann, 2012.
4. N. Mathivanan, **"**Microprocessors, PC Hardware and Interfacing**"**, Prentice Hall, 2004.
5. Y. C. Lieu and G. A. Gibson, **"**Microcomputer Systems: The 8086/8088 Family**"**, Prentice Hall India, 1986.

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6. J. Uffenbeck, "The 8086/8088 Design, Programming, Interfacing", Prentice Hall, 1987.
7. B. Govinda rajalu, "IBM PC and Clones", Tata McGraw Hill, 1991.
8. P. Able, "8086 Assembly Language Programming", Prentice Hall India.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU526 D.1 Understand the computer organization
EEU526 D.2 Understand the memories of computer
EEU526 D.3 Understand the Input/Output organization of computer
EEU526 D.4 Understand the 16 bit and 32 bit Microprocessors
EEU526 D.5 Understand the pipelining and different architectures of computer systems

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU526 D.1	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU526 D.2	2	2	2	3	0	0	0	0	0	0	0	0	2	0	0
EEU526 D.3	2	3	2	2	2	0	0	0	0	0	0	0	2	0	0
EEU526 D.4	2	2	2	1	1	0	0	0	0	0	0	0	2	0	0
EEU526 D.5	2	2	1	1	1	0	0	0	0	0	0	0	2	0	0

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EEU526(E) EMBEDDED SYSTEM

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. To provide an overview of Design Principles of Embedded System.
II. To provide clear understanding about the role of firmware, operating systems in correlation with hardware systems.
III. To provide fundamentals about communication and synchronization

Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

Typical Embedded System: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.

Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

Text Books:

1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.
2. Embedded Systems - Raj Kamal, TMH.

Reference Books:

1. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
2. Embedded Systems – Lyla, Pearson, 2013
3. An Embedded Software Primer - David E. Simon, Pearson Education.

Course Outcomes:

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At the end of this course, students will demonstrate the ability to

EEU526E.1 Understand the selection procedure of Processors in the Embedded domain.

EEU526E.2 Understand the typical embedded system

EEU526E.3 Design Procedure for Embedded Firmware.

EEU526E.4 Expected to visualize the role of Real time Operating Systems in Embedded systems

EEU526E.5 Expected to evaluate the Correlation between task synchronization and latency issues

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU526E.1	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU526E.2	2	2	2	3	0	0	0	0	0	0	0	0	2	0	0
EEU526E.3	2	3	2	2	2	0	0	0	0	0	0	0	2	0	0
EEU526E.4	2	2	2	1	1	0	0	0	0	0	0	0	2	0	0
EEU526E.5	2	2	1	1	1	0	0	0	0	0	0	0	2	0	0

0- Not correlated 1 - Weakly Correlated 2- Moderately Correlated 3- Strongly Correlated

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EEU527 POWER ELECTRONICS LAB.

Teaching Scheme: 02P **Total: 02** **Credits: 01**

Evaluation Scheme: 25ICA + 25 ESE **Total Marks: 50**

Course Objectives:

I. Characteristics of various power semiconductor devices
II. Functioning of various power converters
III. Simulation of power converters to get desired output

Minimum Eight Experiments must be performedcoveringtheentireSyllabus of EE602, PowerElectronics Representativelist is given follows: AnyTHREEfrom 1 to 5

1.SCR/ GTOCharacteristics.
2.SCR Turn-on methods.
3.SCR Commutation methods.
4.IGBT / MOSFET Characteristics, Drivers.
5.TRIAC – Triggering modes and Phase control. Any**THREE**from 5 to 10
6.Single phaseHalf / Full Controlled Converter.
7.Single phaseDual Converter.
8. Thyristorised / Transistorized D.C. Chopper.
9. Single phase Thyristorised / Transistorised Inverter.
10.Single phase Cycloconverter / A.C. Regulator.

Any **TWO** from 11 to 15

11.Simulation of Converter/ Chopper.
12.Simulation ofInverter / Cycloconverter.
13.Simulation of TriggeringScheme / PWM Technique.
14.Switched mode Converter/ Rectifier.
15.UninterruptiblePower Supply.

ICA-

InternalContinuousAssessmentshallbebasedonthepracticalrecordandknowledge/skillsacquired .Theperformanceshallassessexperimentwisebyusingcontinuousassessment formats, A andB.

ESE -The EndSemester Exam for practical shall be based on performance in one of experiments and maybefollowed bysample questions.

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Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU529.1 Select appropriate semiconductor device for building a power converter.

EEU529.2 Develop the power converter required for given application.

EEU529.3 Simulate the power converter before its prototype.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU529.1	2	1	0	0	0	0	0	0	0	0	0	0	1	2	1
EEU529.2	1	1	2	2	1	0	0	0	0	0	0	0	1	2	1
EEU529.3	0	1	1	2	2	0	0	0	0	0	0	1	1	1	1

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EEU528Power Systems – Apparatus and Modelling Lab

Teaching Scheme : 02 P Total 02 **Credit: 01**

Evaluation Scheme :25 ICA + 25 ESE **Total Marks: 50**

Course Objectives:

To make the students aware and understand:

1. Use of MATLAB and other tools on power system studies
2. Electrical power system modeling for steady state studies
3. Analyze the symmetrical and unsymmetrical faults

The laboratory consists of minimum ten experiments from following list and any other experiment based on the prescribed syllabus

1. To determine the inductance (L) per phase per km of unsymmetrical three phase line.
2. To determine the inductance of three phase double circuit transmission line.
3. To determine the capacitance of symmetrical three phase transmission line.
4. To find Capacitance of an Unsymmetrical three phase transposed line.
5. Analyze the reactive power requirement of lines, voltage profile along the line and VAR compensation.
6. To determine A, B, C, D constants of a given transmission line
7. Simulation of typical power system- familiarization with generator, line and load models.
8. Simulation and analysis for a symmetrical three phase fault.
9. Simulation and analysis of unsymmetrical fault - LL, LG and LLG.
10. Visit to HV/EHV substation, power generating station.
11. To study EHVAC transmission line simulator.
12. Simulation of generation of over-voltages and surges.
13. Study of insulation Coordination in power system

Course Outcomes:

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

EEU528.1 Model and simulate single-machine power system for steady state study

EEU528.2 Analyze transmission line parameters (L,C)per kilometer of unsymmetrical and symmetrical line for different configurations

EEU528.3 To determine A, B, C, D constants of a given transmission line

EEU528.4 Analyze the symmetrical and unsymmetrical faults

EEU528.5 Study of insulation coordination in power system

ICA - Internal Continuous Assessment shall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

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CO-PO-PSO Mapping: (3 High, 2 Medium and 1 Low)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	P O 11	PO1 2	PSO 1	PSO 2	PSO 3
EEU528. 1	3	2	1	2	3	2	2	2	--	1	1	1	2	1	2
EEU528. 2	2	2	1	2	3	1	2	1	--	1	--	1	2	1	2
EEU528. 3	2	2	1	2	3	1	2	1	--	1	--	1	2	1	2
EEU528. 4	2	2	3	1	3	1	1	1	-	1	1	1	2	2	2
EEU528. 5	3	2	3	1	3	1	3	3	-	1	1	1	1	1	3

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EEU529 CONTROL SYSTEM LAB

Teaching Scheme: 02P **Total: 02** **Credits: 01**

Evaluation Scheme: 50ICA **Total Marks: 50**

Course Objectives:

I. Develop the mathematical model of different components of linear feedback control system using simulation and experiments.
II. Analyze the transient characteristics of different first order and second order systems using simulation and experiments.
III. Determine the performance of system using root locus.

Minimum Eight Experiments to beperformed coveringtheentireSyllabusofEEU523 ControlSystem.Representative list is as follows

1. To determinetransferfunction ofgiven D.C.generator
2. To study potentiometers and Synchronous as error detector
3. To determine closed loop responseoffirst ordersystem
4. To determine closed loop response ofsecond order system
5. To plot frequencyresponseofgiven leadcompensator
6. To obtain root locus experimentally.
7. Use MATLAB to study effect of feedback gain on system response.
8. Use MATLAB to study effect of damping factor zeta on time control performance specifications.
9. Use MATLAB to obtain root locus for a given system and find performance specifications there from. Study effect of addition of zero and pole on root locus
10. Use MATLAB to get bode plot and obtain gain margin and phase margin for various systems.
11. Use of MATLAB to obtain Nyquistplot &therefrom obtaingain &phasemargin forgiven System
12. Use MATLAB to obtain state space representation from transfer function, find Eigen values, Analyze controllability, observability and stability.

ICA-

InternalContinuousAssessmentshallbebasedonthepracticalrecordandknowledge/skillsacquired .Theperformanceshallassessexperimentwisebyusingcontinuousassessment formats, A andB.

ESE - The End Semester Exam for practical shall be based on performance in one of experiments and maybefollowed bysample questions.

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Course Outcomes:

At the end of this course, students will demonstrate the ability to

EEU530.1 Select appropriate semiconductor device for building a power converter.

EEU530.2 Develop the power converter required for given application.

EEU530.3 Simulate the power converter before its prototype.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU530.1	1	1	0	2	0	0	0	0	0	0	0	0	2	1	0
EEU530.2	2	1	0	2	0	0	0	0	0	0	0	0	2	1	0
EEU530.3	2	1	0	2	3	0	0	0	0	0	0	0	2	1	0

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EEU530 MICROPROCESSOR AND MICROCONTROLLERSLAB

Teaching Scheme: 02P **Total: 02** **Credits: 01**

Evaluation Scheme: 50ICA **Total Marks: 50**

Course Objectives:

I. Functional hardware components of a microprocessor and microcontroller
II. Fundamental programming skills for microcontroller-based system
III. Skill to interface a variety External device with microcontrollers

Minimum Eight Experiments to be performed covering the entire Syllabus of EEU523 Control System. Representative list is as follows

1. Write a a program to store data into given RAM memory locations using direct and indirect addressing modes
2. N 8 bit numbers stored in internal data memory write a program to arrange the numbers in descending order and ascending order
3. Write a program to create a delay of 1000ms. Assume that the oscillator frequency is 12 MHz
4. Write a program to toggle alternate bits at port 1
5. Write a program to receive 8 bits data from port0 port1. Perform AND operation of the received data and send the results to port2
6. Write a program for Hexadecimal up counter
7. Interface DAC and write program to generate square wave
8. Write a program to start A/D converter and store the results in accumulator
9. Interface a stepper motor and write a program to rotate the stepper motor in the direction given in the program
10. Interface a DC motor and write a program to rotate the DC motor for a given speed

ICA-

InternalContinuousAssessmentshallbebasedonthepracticalrecordandknowledge/skillsacquired .Theperformanceshallassessexperimentwisebyusingcontinuousassessment formats, A andB.

ESE - The End Semester Exam for practical shall be based on performance in one of experiments and maybefollowed bysample questions.

Course Outcomes:

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

EEU530.1 Design the microcontroller-based systems

EEU530.2 Develop the programs in assembly/C language for a microcontroller-based system

EEU530.3 Demonstrates the skills to interface the external devices with microcontrollers

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU530.1	3	1	1	3	0	0	0	0	0	0	0	0	1	3	0
EEU530.2	3	3	3	2	2	0	0	0	0	0	0	0	2	3	0
EEU530.3	3	3	3	2	3	0	0	0	0	0	0	0	2	3	0

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EEU621 POWER SYSTEM –OPERATION AND CONTROL

Teaching Scheme : 03 L Total: 03 Credit: 03
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

I. Use numerical methods to analyse a power system in steady state.
II. Explain stability constraints in a synchronous grid.
III. Understand methods to control the voltage, frequency, and power flow.

Power Flow Analysis: Review of the structure of a power system and its components. Analysis of power flows.Formation of bus admittance matrix, real and reactive power balance equations at a node. Load and generator specifications.Application of numerical methods for solution of non- linear algebraic equations – Gauss Seidel and Newton –Raphson methods for the solution of the power flow equations.Computational issues in large-scale power systems.

Stability Constraints in Synchronous Grid: Swing equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomenon of loss of synchronism in a single-machine infinite bus system following a disturbance like a three—phase fault. Analysis using numerical integration of swing equations (using methods like forward Euler, Runge-Kutta 4^{th}order methods), as well as the equal area criterion. Impact of stability constraints on power system operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

Control of Frequency and Voltage: Turbines and speed-governors, frequency dependence of loads, droop control and power sharing. Automatic generation control. Generation and absorption of reactive power by various components of a power system. Excitation system control in synchronous generators, automatic voltage regulators. Shunt compensators, Static VAR compensators and STATCOMs. tap changing transformers. Power flow control using embedded DC links and phase shifters.

Monitoring and Control: Overview of energy control centre functions: SCADA systems. Phasor measurement units and Wide-area measurement systems. State-estimation, system security assessment. normal, alert, emergency, extremis states of a power system, contingency analysis, preventive control and emergency control.

Power System Economics and Management: Basic pricing principles: Generator cost curves, utility functions, power exchanges, spot pricing. Electricity market models (vertically integrated, purchasing agency, whole-sale competition, retail competition), Demand side-management. transmission and distributions charges, ancillary services, regulatory framework.

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Text Books:

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.

Reference Books:

1. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
2. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
3. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

Course Outcomes:

On completion of the course, students will demonstrate the ability to

EEU621.1. Apply numerical methods to analyse a power system in steady state.
EEU621.2. Investigate the stability of the system using Swing Equation.
EEU621.3. Solve power system problems for frequency and voltage control.
EEU621.4. Understand the monitoring and control of a power system.
EEU621.5. Comprehend the basics of power system economics.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU621.1	2	2	0	1	0	0	0	0	0	0	0	0	1	1	0
U621.2	3	1	0	2	2	0	0	0	0	0	0	0	1	2	0
U621.3	3	1	0	2	2	0	0	0	0	0	0	0	-	3	0
U621.4	1	3	3	2	2	0	0	0	0	0	0	0	2	2	0
U621.5	1	1	0	3	2	0	0	0	0	0	0	0	0	1	0

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EEU622 CONTROL SYSTEM DESIGN

Teaching Scheme : 03 L + 01 T Total: 04 **Credit: 04**
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

To make students aware and understand

1. Understand various design specifications.
2. Design controllers such as P, PI, PID, compensators to satisfy the desired design specifications
3. Design controllers using the state-space approach

.

Design Specifications

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.

Design of Classical Control System in the time domain

Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.

Design of Classical Control System in frequency domain

Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.

Design of PID controllers

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

Control System Design in state space

Review of state space representation and Concept of controllability &observability, effect of pole zero cancellation on the controllability &observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.

Sampled Data Control Systems

Representation, Z Transforms. review, Sampler and Hold - zero order hold; Sampling theorem; Z Transform analysis – open loop and closed loop sampled data systems, Z Transfer functions, Difference equation solution and response; Z Transform Method,. Discrete Systems Response, Open and closed loop systems pulse transfer functions - Different sampler locations; Digital Controller - transfer function; Stability analysis - S and Z Domain relationship, Jury's Test and Bi-Linear Transformation, Root and root locus method.

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Non-Linear System Analysis I
Non-linear system behaviour – types and characteristics; Describing functions - typical non-linearity and their characteristics; Stability analysis - Describing function method and Limit cycles; Limitations - describing function method.

Non-Linear System Analysis II
Linearization - Around operating point; Singular points – Classification and Nature; Phase-plane method - non- linear systems analysis; Phase trajectories construction – analytical method and graphical method by isocline method; Stability analysis - limit cycle; Limitations - phase-plane method.

Text and Reference Books :

1. N. Nise, "Control system Engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
4. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
5. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.
6. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.
7. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994

Course Outcomes:

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

EEU622.1 Understand the design specifications for considering as performance indices.
EEU622.2 Design different compensators for linear-time invariant systems in time and frequency domain
EEU622.3 Design of P, PI, PD and PID controllers in time domain and frequency domain
EEU622.4 Undertake systematic Design of Observer and Reduced order observer
EEU622.5 Analyze sampled data control system
EEU622.6 Analyze different types of non-linearities in the system by describing function and phase plane analysis

CO-PO-PSO Mapping: (3 High, 2 Medium and 1 Low)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU622.1	3	2	--	1	--	--	--	--	--	--	--	--	2	3	--
EEU622.2	3	3	--	2	3	--	--	--	--	--	--	--	1	3	--
EEU622.3	3	3	--	3	2	--	--	--	--	--	--	--	--	3	--
EEU622.4	3	3	3	2	3	--	--	--	--	--	--	--	1	3	--
EEU622.5	3	3	--	3	2	--	--	--	--	--	--	--	--	3	--
EEU622.6	3	3	--	3	2	--	--	--	--	--	--	--	--	3	--

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EEU623 OPERATION RESEARCH TECHNIQUES

Teaching Scheme : 03 L + 01 T Total: 04 **Credit: 04**
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

I. To impart knowledge in concepts and tools of Operations Research
II. To introduce mathematical models used in Operations Research.
III. To introduce students to apply these techniques constructively to make effective decisions.

Introduction: Historical Development, Engineering applications of optimization, statement of an optimization problem, Formulation of optimization problem, classification of optimizati on techniques.

Classical optimization techniques

Single and multi variable optimization without constraints (necessary and sufficient conditions-without proof), Multi variable optimization with equality constraints–Lagrange multiplier method, Optimization with calculus-Kuhn-Tucker conditions.

Linear programming

Graphicalmethod,Simplexmethod,Revisedsimplexmethod,Duality in linear programming (LP), Dual simplex method, Sensitivity analysis, Balanced and unbalanced transportation problem–north west corner method, least cost method and Vogel's approximation method for finding initial basic feasible solution, stepping stone method to find optimum solution, Assignment problem – Hungarian method for findingoptimumsolution.

Non linear programming: Unimodal function, One dimensional minimization-unrestricted search (search with fixed step size and accelerated step size), Fibonancci search method and Golden section method, Unconstrained optimization-direct search method (simplex method), descent method (steepest descent method and conjugate gradient method), Constrained optimization–sequential quadraticprogramming method.

Dynamic programming: Multistage decision processes, concept of sub optimization and principle of optimality, linear programming as a case of dynamic programming, Applications for solving unit commitment problem.

Text Books:

1. Engineering Optimization-Theory and Practice, S.S.Rao Wiley Eastern Ltd.2005
2. Operations Research–Theory and Applications, J.K. Sharma, Macmillan India Ltd., New Delhi. -2009

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Reference Books:

1. Introduction Operations Research, Fredrick S.Hiller Gerald J.L. Lieberman Tata Mc Graw Hill Pub. Co., New Delhi.-2004
2. Operations Research, H.A.Taha PHI, New Delhi.-2000
3. K. Deb," Optimization for Engineering Design–Algorithms and Examples", Prentice-Hall of India Pt. Ltd., New Delhi, 1995.
4. Linear Programming, S.I.Gauss.
5. http://www.nptel.iitmac.in

Course Outcomes:

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

EEU624.1. Formulate the mathematical model for optimization problems.

EEU624.2. Select proper method to solve a given optimization problem.

EEU624.3. Understand the characteristics of different types of decision-making environments and the appropriate decision-making approaches.

EEU624.4. Use quantitative methods and techniques for effective decisions–making.

EEU624.5. Apply appropriate optimization techniques to solve the engineering optimization problems (in general) and electrical engineering optimization problems in specific.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU623.1	3	2	0	1	2	0	0	0	0	0	0	0	0	0	0
U623.2	3	3	0	2	3	0	0	0	0	0	0	0	0	0	0
U623.3	2	1	0	2	2	0	0	0	0	0	0	0	0	0	0
U623.4	2	2	0	2	2	0	0	0	0	0	0	0	0	0	0
U623.5	3	1	0	3	3	0	0	0	0	0	0	2	2	0	1

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EEU624A POWER SYSTEM PROTECTION

Teaching Scheme : 03 L Total: 03 Credit: 03
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

To make students aware and understand

I. Various protection schemes for different power system components.
II. The importance of Digital relays.
III. Develop various protection schemes.

Introduction and Components of a Protection System: Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers

Faults and Over-Current Protection: Review of Fault Analysis, Sequence Networks. Introduction to Over current Protection and over current relay co-ordination.

Equipment Protection Schemes: Directional, Distance, Differential protection, Transformer and Generator protection. Bus bar Protection and Bus Bar arrangement schemes.

Digital Protection: Computer-aided protection, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues.

Modelling and Simulation of Protection Schemes: CT/PT modelling and standards, Simulation of transients using MATLAB or Electro-Magnetic Transients
(EMT) programs. Relay Testing.

System Protection: Effect of Power Swings on Distance RelayingSystem Protection Schemes. Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving
protection systems.

Text Books:

1. J. L. Blackburn, “Protective Relaying: Principles and Applications”, Marcel Dekker, New York, 1987.
2. Y. G. Paithankar and S. R. Bhide, “Fundamentals of power system protection”, Prentice Hall, India, 2010.

Reference Books:

1. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley &

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Sons, 1988.
2. A. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2008.
3. D. Reimert, “Protective Relaying for Power Generation Systems”, Taylor and Francis, 2006.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:
EEU624A.1 Understand the different components of a protection system.
EEU624A.2 Evaluate fault current due to different types of fault in a network.
EEU624A.3 Understand the protection schemes for different power system components.
EEU624A.4 Understand the basic principles of digital protection.
EEU624A.5 Understand system protection schemes, and the use of wide-area measurements.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU624A.1	2	2	0	1	0	0	0	0	0	0	0	0	1	1	0
EU624A.2	3	1	0	2	2	0	0	0	0	0	0	0	1	2	0
EU624A.3	3	1	0	2	2	0	0	0	0	0	0	0	0	3	0
EU624A.4	1	3	3	2	2	0	0	0	0	0	0	0	2	2	0
EU624A.5	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0

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EEU624 B ENERGY CONSERVATION IN ELECTRICAL UTILITIES

Teaching Scheme : 03 L Total: 03 Credit: 03
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

I. Energy conservation management system.
II. Energy audit as per energy conservation act.
III. Lighting level and motor efficiency.

Energy Conservation: Energy Conservation Principles, Energy conservation Planning, Energy conservation in small- and Large-scale industries, Energy conservation in electrical generation, transmission and distribution, Energy Conservation Act 2001 and Bureau of Energy Efficiency.

Energy Audit: Aim of energy Audit, Strategic of Energy Audit, Energy management Team Consideration in implementing energy conservation Program, Instruments for energy audit, Energy audit of Electrical Systems, HVAC, Buildings, Economic analysis.

Demand Side Management: Concept and Scope of Demand Side Management, Evolution of Demand Side Management, DSM Strategy, Planning, Implementation and its application, Customer Acceptance & its implementation issues.

Efficiency in Motors and Lighting system: Load scheduling/shifting, **Motor Drives**-motor efficiency testing, energy efficient motors, motor speed control. **Lighting**- lighting levels, efficient options, fixtures, day lighting, timers, Energy efficient windows, UPS selection, Installation operation and maintenance.

Energy management systems: Introduction, energy conservation policy and performance assessment, baseline and benchmarking, action planning, monitoring and targeting, energy management information systems, CUSUM techniques.

Text Books

1. Doty S. and Turner W. C. (2012); Energy Management Handbook, Eighth Edition, Fairmont Press
2. Bureau of Energy Efficiency (BEE) (2012); Study material for Energy Managers and Auditors Examination: Paper I to IV
3. Bureau of Energy Efficiency (BEE) (2015); Electrical Efficiency in Electrical Utilities-Book3

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Reference Books

1. Thumann A. and Mehta D. P. (2008); Handbook of Energy Engineering, Sixth Edition, Fairmont Press
2. Capehart B. L. Turner W. C. and Kennedy W. J. (2011); Guide to Energy Management, Seventh Edition. Fairmont Press
3. Kao C. (1999); Energy Management in Illumination System, First Edition, CRC Press
4. http://www.nptel.iitm.ac.in/
5. http://www.ocw.mit.edu/

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto

EEU624B.1. Understand the energy conservation as per conservation legislation in electrical utility.

EEU624B.2. Describe the energy audit in electrical systems.

EEU624B.3. Explain the evolution of Demand Side Management.

EEU624B.4. Illustrate motor and lighting system efficiency.

EEU624B.5. Understand energy management systems informative strategy and policy.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU624B.1	2	2	1	1	1	0	0	0	0	0	0	0	2	0	0
EU624B.2	2	3	2	2	2	0	0	0	0	0	0	0	2	0	0
EU624B.3	2	3	3	2	2	0	0	0	0	0	0	0	2	0	0
EU624B.4	2	2	1	2	2	0	0	0	0	0	0	0	2	0	0
EU624B.5	3	3	3	2	3	0	0	0	0	0	0	0	2	0	0

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EEU624D OBJECT ORIENTED PROGRAMMING

Teaching Scheme : 03 L Total: 03 Credit: 03
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

I. Standard tools and techniques for software development
II. Use of object-oriented approach.
III. An appropriate framework for automated unit

Abstract Data Types, Functions and Operations: Abstract data types and their specification**,** How to implement an ADT. Concrete state space, concrete invariant, abstraction function. Implementing operations, illustrated by the Text example.

Basic Features: Features of object-oriented programming, Encapsulation, object identity, polymorphism – but not inheritance.

Design of Patterns and its study: Inheritance in OO design**,** Design patterns. Introduction and classification. The iterator patterns.

Implementation of OO features: Model-view-controller pattern. Commands as methods and as objects., Implementing OO language features. Memory management. Generic types and collections

GUIs and development processes: GUIs Graphical programming with Scala and Swing, The software development process.

Text Books:

1. Barbara Liskov, Program Development in Java, Addison-Wesley,
2. Robert Lafore Object oriented Programming in Microsoft C++

Reference Books:

1. Dusty Phillips Object oriented Programming in Python
2. Mrklutz Programming in Python powerful Object-oriented Programming
3. Bill lubonovic Introducing Python

Course Outcomes:

After taking the course, students will be able to**:**

EEU624D.1 Specify simple abstract data types and design implementations, using abstraction functions to document them.

EEU624D.2 Recognise features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity.

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EEU624D.3 Name some common object-oriented design patterns and give examples of their use.

EEU624D.4 Apply some common object-oriented design patterns and give examples of their use.

EEU624D.5 Design applications with an event-driven graphical user interface.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU624D.1	3	2	0	1	0	0	0	0	0	0	0	0	2	3	0
EU624D.2	3	3	0	2	3	0	0	0	0	0	0	0	1	1	0
EU624D.3	1	2	0	2	2	0	0	0	0	0	0	0	0	2	0
EU624D.4	3	3	3	2	3	0	0	0	0	0	0	0	1	3	0
EU624D.5	1	3	0	3	2	0	0	0	0	0	0	0	0	1	0

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EEU624E- INTERNET OF THINGS

Teaching Scheme : 03 L Total: 03 Credit: 03
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

I. Fundamentals of IoT
II. Different types of IOT sensors
III. IoT applications in Electrical Engineering

INTRODUCTION: Internet of Things Promises–Definition– Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device.

IOT SENSORS: Magnetization, Hysteresis and hysteresis loop, Methods of analysis of ferromagnetic circuits, Fringing and Leakage effects of air gap, Eddy current, eddy current and hysteresis losses, Equivalent circuits of iron core reactors, Saturable reactors.

TECHNOLOGICAL ANALYSIS: Wireless Sensor Structure–Energy Storage Module–Power Management Module–RF Module–Sensing Module.

IOT DEVELOPMENT EXAMPLES:ACOEM Eagle – En Ocean Push Button – NEST Sensor – Ninja Blocks -Focus on Wearable Electronics.

IOT PROJECTS: Creating the sensor project - Preparing Raspberry Pi/ ARM Cortex - Clayster libraries – HardwareInteracting with the hardware - Interfacing the hardware- Internal representation of sensor values - Persisting data - External representation of sensor values – Exporting sensor data - Creating the actuator project- Hardware - Interfacing the hardware -Creating a controller - Representing sensor values - Parsing sensor data – Calculating control states - Creating a camera - Hardware -Accessing the serial port on RaspberryPi/ ARM Cortex - Interfacing the hardware - Creating persistent default settings – Adding configurable properties - Persisting the settings - Working with the current settings - Initializing the camera

Text Books:

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
2. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.

Reference Books:

1. Editors OvidiuVermesan Peter Friess,'Internet of Things – From Research and Innovation to Market

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2. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto

EEU624E.1. Understand the basics of IoT.

EEU624E.2. Compare first generation and advanced IoT sensors.

EEU624E.3. Analyse energy storage, power management, RF and sensing module.

EEU624E.4. Develop applications using sensors and IoT components.

EEU624E.5. Design IoT project using Raspberry pi/ Arm cortex.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU 624E.1	2	2	1	1	1	0	0	0	0	0	0	0	2	0	0
EEU 624E.2	2	3	2	2	2	0	0	0	0	0	0	0	2	0	0
EEU 624E.3	2	3	3	2	2	0	0	0	0	0	0	0	2	0	0
EEU 624E.4	2	2	1	2	2	0	0	0	0	0	0	0	2	0	0
EEU 624E.5	3	3	3	2	3	0	0	0	0	0	0	0	2	0	0

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EEU633A ELECTROMECHANICAL ENERGY CONVERSION

Teaching Scheme : 03 L Total: 03 Credit: 03
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

I. Explain the Terminology of Electromagnetic and Electromagnetic Induction.

II. Induced voltage, armature reaction and torque

III. Dynamics of DC machines

Electrical and Magnetic Field Calculations: Magnetic circuit calculations for devices and machines, Theory of electrostatic and magnetic fields, Fundamental equations, Fields of simple geometries.

Electromechanical Energy Conversion: Energy storage in singly and multiply-excited systems, Mechanical force and stored energy, Electromechanical transducers and their analysis, Reluctance type devices, Energy dissipation- resistance, eddy current, hysteresis and dielectric loss, Lagrange's equation.

Induced Voltage, Armature Reaction and Torque: Induced voltage in windings of ac and dc machines, Armature reaction- EMF of a single coil and uniformly distributed conductors, Rotating magnetic fields in ac machines, Torque in dc and three-phase ac machine, Torque of mutually coupled coils.

Dynamics of Electric Machines: Dynamics of dc machines, Dynamic response of first and second order linear systems, Voltage regulation of separately-excited dc generator, Speed control of separately –excited dc motor, Synchronous-machine dynamics, Parallel operation and synchronizing of alternators.

Text Books:

1. Electro-mechanical energy conversion with dynamics of machines, Rakosh Das Begamudre, Second Edition, New Edge International Publishers, New Delhi.-2008
2. Electric Machines, I J Nagrath and D P Kothari,Tata McGraw-Hill Publishing Company Ltd., New Delhi. 2003

Reference Books

1. Electromechanical Energy Conversion, Vembu Gauri shankar, McGraw Hill.Thumann A. and Mehta D. P. (2008); Handbook of Energy Engineering, Sixth Edition, Fairmont Press
2. Principles of Electro-mechanical energy conversion,Del ToroV, Prentice-Hall, Englewood Cliffs. N. J.
3. http://www.nptel.iitm.ac.in/
4. http://www. southampton.ac.uk/

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Course Outcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto

EEU633A.1. Understand the principals of electromechanical energy conversion

EEU633A.2. Perform electric and magnetic field calculations for devices and machines.

EEU633A.3. Analyse electromechanical transducers and energy conversion process.

EEU633A.4. Determine induced voltages and torque in DC & Induction Machines.

EEU633A.5. Determine dynamic response of linear systems and machines.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU 633A.1	2	2	1	1	1	0	0	0	0	0	0	0	2	0	0
EEU 633A.2	2	3	2	1	1	0	0	0	0	0	0	0	2	0	0
EEU 633A.3	2	3	3	1	1	0	0	0	0	0	0	0	2	0	0
EEU 633A.4	2	2	1	1	1	0	0	0	0	0	0	0	2	0	0
EEU 633A.5	3	3	3	1	1	0	0	0	0	0	0	0	2	0	0

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EEU633B ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

Teaching Scheme : 03 L Total: 03 Credit: 03
Evaluation Scheme : 30 MSE +10 TA+ 60 ESE Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

I. Electrical power system and tariffs in India.

II. Need and Importance of energy saving practices in electrical utilities.

III. Energy saving opportunities in drives, fans, pumps, lighting, DG sets, etc.

Electrical systems: Introduction to Electrical energy systems, Tariff and economic considerations, T & D losses, Electricalload and various factors, Power factor and its introductory improvement techniques, Energy EfficientTechnologies in Electrical Systems

Electric Motors and Drives: Energy Efficient Motors, Factors affecting Energy efficiency of a motorIntroduction to power electronic controllers, soft starters and block diagrams of stator voltage and stator frequency controlled three phase induction motor drives, block diagrams of controlled rectifier and chopper fed dc shunt motor.

Fans and Blowers: Types, efficient system operation, Capacity selections, Performance assessment of fans and blowers, Energy conservation opportunities

Pumping systems: Types, Performance evaluation, efficient system operation, Energy conservation opportunities inpumping systems

Lighting systems: Basic terms of lighting systems recommended illumination level, Methodology of lighting systems, energy efficiency study, and Energy conservation opportunities.

DG Set and UPS systems: Introduction, Selection and capacity factor, Operational parameters, Performance assessment of DG Systems, Energy conservation opportunities, Block diagram and working of UPSEnergy Efficiency in Renewable Energy Systems: Energy efficiency in solar and wind energy systems.

Text Books:

1. Doty S. and Turner W. C. (2012); Energy Management Handbook, Eighth Edition, Fairmont Press
2. Bureau of Energy Efficiency (BEE) (2012); Study material for Energy Managers and Auditors Examination: Paper I to IV
3. Bureau of Energy Efficiency (BEE) (2015); Electrical Efficiency in Electrical Utilities-Book3

Reference Books

1. Thumann A. and Mehta D. P. (2008); Handbook of Energy Engineering, Sixth Edition, Fairmont Press

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3. Kao C. (1999); Energy Management in Illumination System, First Edition, CRC Press
4. http://www.nptel.iitm.ac.in/
5. http://www.ocw.mit.edu/

Course Outcomes:

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

EEU633B.1. Understand the components of electrical energy systems.
EEU633B.2. Apply energy efficient technologies in electrical utilities.
EEU633B.3. Utilize the various energy conservation techniques and practices.
EEU633B.4. Evaluate the performance of various types of electrical loads.
EEU633B.5. Select the proper capacity of various equipment's/accessories for given applications.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU 633B.1	2	1	0	0	0	0	0	0	0	0	0	0	2	2	0
EEU 633B.2	2	2	1	0	2	0	2	0	0	0	0	0	3	2	0
EEU 633B.3	2	2	1	1	2	1	0	0	0	0	0	2	3	1	0
EEU 633B.4	3	2	0	0	0	0	1	0	0	0	0	0	3	2	0
EEU 633B.5	3	0	0	0	3	0	1	0	0	0	0	0	3	1	0

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ETU 631 ELECTRONICS DESIGN LABORATORY

Teaching Scheme: 01T+ 04P **Total: 05** **Credit: 03**
Evaluation Scheme: 55 ICA + 50 ESE **Total Marks: 100**

Course Objectives:

I. To study various measurement devices, their characteristics, operation, and limitations
II. To simulate and synthesize the program on a hardware development board.
III. To study statistical data analysis

Minimum Eight Experiments to be performed to achieve course outcomes.
Following list of laboratory experiments is indicative but not limited to following topics.

1. Designing signal Conditioning circuit for Pressure Measurement

2. Designing signal Conditioning circuit for Temperature Measurement

3. Designing signal Conditioning circuit for Torque Measurement

4. Designing signal Conditioning circuit for Strain Measurement

5. Experimental study for the characteristics of ADC and DAC

6. FPGA implementation of any combinational digital logic design

7. FPGA implementation of any sequential digital logic design

8. Stepper motor control using microcontroller.

9. Temperature control using microcontroller.

10. Serial communication between microcontroller and PC

ICA – The Internal Continuous Assessment shall be based on practical record and knowledge or skills acquired. The performance shall be assessed experiment wise by using continuous assessment format, A & B.

ESE- The End Semester Exam for Practical shall be based on performance in one of the experiments and may be followed by sample questions.

Course Outcomes:

ETU 631.1 Learn about various measurement devices, their characteristics, operation and limitations.

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ETU 631.2 Understand the implementation on hardware development board
ETU 631.3 Understand statistical data analysis

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU631.1	2	0	1	0	0	0	0	1	1	0	0	0	2	1	0
EEU631.2	2	0	2	0	2	0	0	1	1	0	0	0	2	1	0
EEU631.3	2	0	2	0	2	0	0	1	1	0	0	0	2	1	0

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EEU626 POWER SYSTEM –OPERATION AND CONTROLLAB

Teaching Scheme : 02 P Total:02 **Credit: 01**

Evaluation Scheme : 50 ICA **Total Marks: 50**

Course Objectives:

To make the students aware and understand:

I. Usenumericalmethodstoanalyse a powersysteminsteadystate.

II. Understandstabilityconstraintsinasynchronousgrid.

III. Understandmethodstocontrolthevoltage, frequency,andpowerflow.

Minimum eight hands-one experiments related to the course contents of EEU626 Power System Operation and Control Labto be performed. Representative list is as follows.

1. To carry out load flow using Gauss-Seidel method
2. To carry out load flow using NR method
3. Solution of Swing equation by Euler method
4. Solution of swing equation by RK2 method
5. Unit commitment using equal incremental cost method.
6. Modelling and simulation of multi-machine power system
7. Evaluation of the effect of various contingencies and to compute sensitivity factors.
8. To determine the effect of surge impedance loading
9. Determination of steady state power limit of a transmission line.

ICA - Internal Continuous Assessmentshall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

ESE- The End Semester Exam for Practical shall be based on performance in one of the experiments and may be followed by sample questions.

Course Outcomes:

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

EEU626.1 Model and simulate multi-machine power systems for steady state andtransientstudies.

EEU626.2 Simulate the steady state and transient operations using MATLAB.

EEU626.3 Perform various contingencies on power system and compute sensitivityfactors.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU626.1	2	2	2	1	2	0	0	0	0	0	0	0	1	1	1
EEU626.2	2	1	1	2	2	0	0	0	0	0	0	0	1	2	2
EEU626.3	1	3	2	2	2	0	0	0	0	0	0	0	1	3	2

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EEU627 CONTROL SYSTEM DESIGN LAB

Teaching Scheme : 02 P Total:02 **Credit: 01**
Evaluation Scheme : 50 ICA **Total Marks: 50**

Course Objectives:

To make the students aware and understand:

I. Develop the mathematical model of different components of linear feedback control system using simulation and experiments.
II. Analyse the transient characteristics of different first order and second order systems using simulation and experiments.
III. Determine the performance of system using root locus.

Minimum Eight Experiments to be performed covering the entire Syllabus of EEU622 Control System Design. Representative list is as follows [Minimum fivefrom part A &remaining from partB]

Part A:

1. To plot frequencyresponseofgiven leadcompensator
2. To plot frequencyresponseofgiven lagcompensator
3. To plot frequencyresponseofgivenLag-Leadcompensator.
4. Design&implement alag compensator forgiven plant to meet thegivenspecifications.
5. Design&implement alead compensator forgiven plant to meet thegivenspecifications.
6. To determinethe describingfunction ofgivenrelay.
7. To determineeffect ofrelaytypeof nonlinearityon closed loop system
8. To determinethe phaseplanetrajectoryforgiven nonlinear system

Part B:

1. Overview of functionsin MATLABcontrol system toolbox
2. To obtain thephaseplaneplotofgiven mechanical system
3. Obtain thephaseplaneplotof given electrical system.
4. To obtain state model forgiven transferfunction
5. To obtain transferfunction from given statemodel

ICA - Internal Continuous Assessmentshall be based on the practical record and knowledge /skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.

ESE- The End Semester Exam for Practical shall be based on performance in one of the experiments and may be followed by sample questions.

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Course Outcomes:

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

EEU627.1 Design and fabricate different compensators.

EEU627.2 Generate characteristics of different types of non-linearities.

EEU627.3 Use software to demonstrate different performance characteristics of LTI systems via state space modelling.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU627.1	2	0	1	0	0	0	0	1	1	0	0	0	2	1	0
EEU627.2	2	0	2	0	2	0	0	1	1	0	0	0	2	1	0
EEU627.3	2	0	2	0	2	0	0	1	1	0	0	0	2	1	0

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EEU628 MINOR PROJECT

Teaching Scheme : 02 P **Total: 02** **Credit: 01**
Evaluation Scheme : 25 ICA + 25 ESE **Total Marks: 50**

For minor project group of four students is to be formed. Innovative ideas of students are expected to be implemented in hardware / fabrication/prototype development/experimentation.
Two groups will be assigned to each guide so that the same students will come for the main project of final year.

Course Objectives:

I. The main aim of this course is to demonstrate the important attributes like critical thinking, creativity, collaborative efforts and communication skills.
II. To make students aware with the process involved in making product from idea.
III. To make student communicate effectively on complex engineering activities with the engineering community and to make students to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes:

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

EEU628.1. Understand community needs.
EEU628.2. Convert idea into product.
EEU628.3. Work in group and Communicate effectively.

CO-PO-PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU628.1	1	2	3	2	2	1	2	1	2	1	2	1	1	1	1
EEU628.2	2	2	2	2	2	3	3	2	2	2	2	2	1	2	2
EEU628.3	1	2	1	2	1	3	3	3	2	3	2	2	1	2	3

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EEU721 ELECTRICAL DRIVES AND CONTROL

Teaching Scheme: 03 L + 00 T **Total: 03 Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2 Hrs.30 min

Course Objectives:

I. To expose students to the operation, application and control of power conversion systems employing electric drive to cater to industrial needs.
II. To familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications.
III. To provide strong foundation to asses performance of different industrial drives considering issues such as, energy efficiency, power quality, economic justification, environmental issues, and practical viabilities.

Introduction to Electrical Drives: Concept, Classification and Advantages. Basic elements, Components of load torque, Torque equation, Equivalent values of drive parameters .Types of mechanical loads. Selection of motor and Controller, Classes of duty, Stability of an electrical drive. Comparison of AC and DC drives.

Starting and Braking of Electrical Drives: Solid-state starters, soft starting, Calculation of starting/acceleration/reversal time and energy loss during starting. Types, advantages, limitations and purposes/objectives of electrical braking, braking of dc and induction motors.

DC Drives: Single phase half, full and dual converter based dc drives-Circuit configurations, input output waveforms, Calculation of torque, speed, power factor, firing angle etc. Torque-Speed characteristics. DC Chopper based dc drives- Circuit configurations, input-output waveforms, Calculation of torque, speed, duty cycle etc. Torque-speed characteristics.

Induction Motor Drives: Scalar control of induction motor–stator voltage and stator frequency control using stator voltage controllers and inverters–circuit configurations, calculation of current, torque, speed etc. Torque-Speed characteristics .Slip power recovery schemes–rotor chopper/ inverter control of induction motor-Circuit on figurations and theoretical concepts only.

Industrial Applications: Electrical drives system for Rolling mills, paper mills, cement mills, sugar mills, textile mills, and traction and machine tool applications.

Text Books:

1. Fundamentals of Electrical Drives, G. K. Dubey, Narosa Publishing House, 2005
2. Electric Drives-Concepts and Applications, V.Subrahmanyam TMH Pub, 2004
3. Modern Power Electronics and AC Drives by B.K.Bose Pearson Education, Asia, 2003
4. Electric Drives, De and Sen PHI Pub,1999

References Books:

1. Thyristor DC Drives P.C. Sen John Wiley & Sons, 1981.

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2. Power Electronic Control of AC Motors" ,JMD Murphy & FG Turnbull, Pergamon Press,1988.
3. Power Semiconductor Controlled Drives", G.K.DubeyPH Int., 1989.
4. Power Semiconductor Drives" Deewan, Straughan & Slemon John Wiley & Sons.
5. http://www.nptel.iitm.ac.in/
6. www.ocw.mit.edu

Course Outcomes:

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

EEU721.1. Identify various electrical controllers/motors and their functions/ characteristics.
EEU721.2. Select proper motor and controller for given application.
EEU721.3. Analyze motor and load characteristics for stability investigation.
EEU721.4. Select suitable starting, braking and speed control equipments, for DC & IM Drives
EEU721.5. Simulate various motor-controller combinations for performance determination.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU721.1	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0
EEU721.2	2	1	0	1	0	0	0	0	0	0	0	0	2	2	0
EEU721.3	2	3	0	1	2	0	0	0	0	0	0	0	1	0	0
EEU721.4	2	1	2	0	0	0	0	0	0	0	0	0	1	0	0
EEU721.5	2	2	0	0	3	0	0	0	0	0	0	0	1	2	

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EEU722A EHV AC TRANSMISSION

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

IV. To Provide In-depth understanding of different aspects of Extra High Voltage AC transmission system design and Analysis.
V. To understand the concept of Voltage gradients of conductors.
VI. To understand the Electrostatic field and its effects over humans, animal and plants.

Extra High Voltage AC Transmission: Introduction to EHV-AC transmission, transmission line trends & preliminary aspects, standard transmission voltages-power handling capacities and line losses mechanical aspects.

Electrostatic Field of EHV Lines: electric shock & threshold currents, capacitance of long object, Effect of Electrostatic field on Human, Animal.

Over Voltages in EHV System: origin & causes, over voltage caused by switching operations, over voltage caused by interruption of low inductive current, over voltage caused by interruption of capacitive currents, Ferro-resonance overvoltage Power frequency voltage control, shunt & series compensation.

Voltage Gradients of Conductors: Electrostatics – field of sphere gap – field of line changes and properties – charge – potential relations for multi-conductors – surface voltage gradient on conductors – distribution of voltage gradient on sub conductors of bundle – Examples.

Lightning: Lightning strokes, Lightening stroke to tower and midspan, Insulation coordination based on lightning.

Traveling Wave Theory: Traveling wave expression and solution- source of excitation-terminal conditions- open circuited and short-circuited end- reflection and refraction coefficients-Lumped parameters of distributed lines generalized constants-No load voltage conditions and charging current.

Corona Effects: Power loss and audible noise (AN) – corona loss formulae – charge voltage diagram – generation, characteristics - limits and measurements of AN – relation between 1-phase and 3-phase AN levels.

Text Books

3. Extra High Voltage AC Transmission Engineering, Rakosh Das Begamudre ,New Age International(P) Ltd
4. HVAC and DC Transmission, by S. Rao, 3rd edition , Khanna Publishers, 2001

Reference Books

1. Extra high voltage AC Transmission Engineering by Rakosh Das Begamudre , Wiley Eastem LTD.

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2. EHV Transmission line Edison-Electric institution.
3. www.nptel.iitm.ac.in

Course Outcomes:

On completion of the course, students will be able to:

EEU722A.6 Learn about the trends in EHV AC Transmission.
EEU722A.7 Understand electrostatic field of EHV AC lines.
EEU722A.8 Study overvoltage phenomenon in EHVAV system.
EEU722A.9 Lightning phenomenon in EHV AC lines.
EEU722A.10 Students will understand the effects of corona like Audible noise.

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU722A.1	2	0	0	0	0	0	0	0	0	0	0	0	2	1	0
EEU722A.2	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0
EEU722A.3	3	3	2	2	2	0	0	0	0	0	0	0	2	2	0
EEU722A.4	2	3	0	1	2	0	0	0	0	0	0	0	2	2	0
EEU722A.5	2	1	0	0	0	0	0	0	0	0	0	0	1	1	0

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EEU722B HIGH VOLTAGE ENGINEERING

Teaching Scheme: 03 L + 00 T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2 Hrs.30 min.

Course Objectives:

I. To gain the knowledge in testing of high voltage equipments.
II. To understand breakdown mechanism of gases, liquid and solid dielectrics.
III. To describe the principals behind generating high DC-AC and impulse voltages

Mechanism Of Breakdown In Gases: Classification of insulating materials. Gases as insulating media, Ionization & decay process, breakdown in gases, Townsend's law. The streamer mechanism of spark Paschen's law, corona discharge, electronegative gases

Breakdown In Liquid And Solid Dielectrics : Breakdown in pure and commercial liquids, Solid Dielectrics and composite dielectrics, High Voltage bushings, Guarding, Shielding, Field Plotting.

Lightning and Switching over Voltages and Protection: Lightning strokes to lines and towers, mechanism & characteristics. Protection of transmission lines from lightning, Lightning Arrestors. Insulation to co-ordination of HV and EHV transmission line, Power system and substation.

High Voltage and Current Generation: Generation of High D.C, A.C. and Impulse voltages, and Standard impulse wave shapes, Switching Surges, High Impulse Generator

High Voltage And Current Measurement: Peak voltage, Impulse voltage and High Direct current Measurement methods, Non-destructive measurement and testing, High Voltage dielectrics Loss and capacitance measurement, Radio Frequency and partial discharge measurement.

High Voltage Testing: Basic Terminology, Testing – Insulation, Bushings, Cables, Transformers, Surge
Diverters and Isolators, Electric Shock and threshold current

Text Book

1. High Voltage Engineering, Naidu M.S. and Kamaraju V Tata McGraw Hill Pub. Co. New Delhi Third Edition

Reference Books

1. High Voltage Engineering, E. Kuffel and W.S. Zaenglo, Pergamon Press
2. EHV AC Transmission Engineering, Rokosh Das Begamudre, Wiley Eastern Ltd. New Delhi.
3. High Voltage Engineering, D.V.Razevig, Khanna Pub. New Delhi
4. http://www.nptel.iitm.ac.in/
5. www.ocw.mit.edu

Course Outcomes

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

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EEU722.B.1. Demonstrate breakdown mechanism of gases, liquid and solid dielectrics.
EEU722.B.2. Understand lightning, switching over voltages and their protection.
EEU722.B.3. Understand the methods of high voltage and current generation.
EEU722.B.4. Describe measurement techniques for high voltage and current.
EEU722.B.5. Understand basic terminology of high voltage testing.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU722.B.1	2	1	1	0	1	2	1	0	0	0	0	0	1	0	0
EEU722.B.2	2	1	1	0	1	2	1	0	0	0	0	0	2	0	0
EEU722.B.3	2	2	2	0	2	1	1	0	0	0	0	0	2	1	0
EEU722.B.4	2	2	2	0	1	2	0	0	0	0	0	0	2	2	0
EEU722.B.5	2	1	2	0	1	-0	0	0	0	0	0	0	2	2	0

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EEU722C AI AND MACHINE LEARNING

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. To understand fuzzy logic, ANN
II. To understand machine learning and algorithm
III. To understand Probability and Bayes learning

Biological Foundations to Intelligent Systems: Artificial Neural Networks, Single layer and Multi layer Feed Forward ANN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks.

Fuzzy Logic: Knowledge Representation and Inference Mechanism, De fuzzification Methods, System Identification using Fuzzy and Neural Network

Introduction to Machine Learning: Basic definitions, types of learning, designing a learning system, perspectives and issues, hypothesis space and inductive bias, evaluation, cross- validation. Linear regression, Decision trees, Splitting Criteria, Issues in decision tree learning, over-fitting and evaluation, nearest neighbor methods.

Neural Network: Perceptron, multilayer network, back propagation, introduction to deep neural network. Dimensionality Reduction: Feature reduction, Principal Component Analysis, Fischer's Discriminant Analysis. Probability and Bayes learning, Naive Bayes Model, Logistic Regression, Reinforcement learning.

Support Vector Machine: Kernel function and Kernel SVM, Clustering: partitioning, k-means clustering, hierarchical clustering, and Case studies

Text Books:

1. An Introduction to ANN, J M Zurada Jaico Publishing House
2. Introduction to Machine Learning, Ethem Alpaydin Second Edition, The MIT Press, 2010.

Reference Books:

1. Neural Networks, Simon Haykins, Prentice Hall
2. Machine Learning,Tom Mitchell,McGraw-Hill

Course Outcomes:

On completion of the course, students will be able to:

EEU722C.1. Learn the concepts of biological foundations of artificial neural networks.
EEU722C.2. Learn Feedback networks and radial basis function networks and fuzzy logics
EEU722C.3. Identify fuzzy and neural network
EEU722C.4. Explain the basic concepts of machine learning
EEU722C.5. Demonstrate fundamental issues and challenges of machine learning algorithms

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CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU722C.1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0
EEU722C.2	1	1	2	0	2	0	0	0	0	0	0	0	0	2	0
EEU722C.3	1	1	2	2	0	0	0	0	0	0	0	0	0	2	0
EEU722C.4	1	2	2	2	1	0	0	0	0	0	0	0	0	0	1
EEU722C.5	1	3	0	0	2	0	0	0	0	0	0	0	1	0	0

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EEU722 D DATA STRUCTUES

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. To Apply software development life cycle in software industry
II. To Identify the importance of software requirements problem to understand the requirement management process Imparting the knowledge of the memory management
III. Design and analyze effective use of UML using different design strategies

Review of Basic Concepts: Abstract data types, Data structures, Algorithms, Big Oh, Small Oh, Omega and Theta notations, Solving recurrence equations, Master theorems, Generating function techniques, Constructive induction

Advanced Search Structures: for Dictionary ADT Splay trees, Amortized analysis, 2-3 trees, 2-3-4 trees, Red-black trees, Randomized structures, Skip lists, Treaps, Universal hash functions, Tire ; Hashing: Simple tabulation hashing; chaining, dynamic perfect hashing, linear probing, cuckoo hashing

Union Find Related Structures: Union-Find: Merging Classes of a Partition, Union-Find with Copies and Dynamic Segment Tree, List Splitting, Problems on Root-Directed Trees, Maintaining a Linear Order

Data Structures for Partition: ADT Weighted union and path compression, Applications to finite state automata minimization, Code optimization

Data Structure Transformations: Making Structures Dynamic, Making Structures Persistent Computational Geometry Geometric data structures, Plane sweep paradigm Convex Hull Different Paradigms and Quickhull , Dual Transformation and Applications , Lower Bounds on Algebraic tree model , Point Location and Triangulation

Text Books:

1. Introduction to Algorithms; 3rd Edition; by by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein; Published by PHI Learning Pvt. Ltd. ; ISBN-13: 978-0262033848 ISBN-10: 0262033844
2. Algorithms; 4th Edition; by Robert Sedgewick and Kevin Wayne; Pearson Education, ISBN-13: 978-0321573513
3. Advanced Data Structures, Peter Brass, Cambridge University Press, ISBN-13: 978-0521880374

Reference Books:

1. Algorithms; by S. Dasgupta, C.H. Papadimitriou, and U. V. Vazirani Published by Mcgraw-Hill, 2006; ISBN-13: 978-0073523408 ISBN-10: 0073523402

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2. Algorithm Design; by J. Kleinberg and E. Tardos; Published by Addison-Wesley, 2006; ISBN-13: 978-0321295354 ISBN-10: 0321295358
3. An Integrated Approach to Software Engineering, Pankaj Jalote Narosa publication house.

Course Outcomes:

On completion of the course, students will be able to:

EEU722D.1. Describe the data type and structure.

EEU722D.2. Apply data structure for minimization and code optimization

EEU722D.3. Describe the advanced search structures

EEU722D.4. Devise the procedure to assure the quality and maintainability of the product before and after deployment

EEU722D.5. Summarize different testing strategies

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU722D.1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0
EEU722D.2	1	1	2	0	2	0	0	0	0	0	0	0	0	2	0
EEU722D.3	1	1	2	2	0	0	0	0	0	0	0	0	0	2	0
EEU722D.4	1	2	2	2	1	0	0	0	0	0	0	0	0	0	1
EEU722D.5	1	3	0	0	2	0	0	0	0	0	0	0	1	0	0

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EEU722E ENERGY STORAGE SYSTEMS

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Understand energy storage systems.
II. Study the technology in energy storage systems.
III. Study the types of energy storage systems.

Fundamentals of Energy Storage Systems: Introduction and Fundamentals of energy storage, energy density, power density; Electrochemical storage components; Super capacitors; Hydraulic storage; Flywheels; Compressed air energy storage; concept of load dispatch centre, effect of renewable integration in to grid.

Technologies in Energy Storage Systems: Overview of energy storage in the Thermal, Chemical and Electrochemical systems, Electrical Efficiency of energy storage systems, Electrical energy storages: Batteries, Super capacitors, super conducting Magnetic Energy Storage (SMES), charging methodologies, State of Charge (SoC), State of Health (SoH) estimation techniques. Hydrogen production and storage, fuel cells.

Types of Energy Storage Systems: Mobile storage system: electric vehicle, Grid to Vehicle (G2V) and Vehicle to grid (V2G). Hybrid Energy storage systems: configurations and applications. Storage for renewable energy systems: Solar energy, Wind energy, fuel cells. Energy storage in Micro grid and Smart grid. Energy Management with storage systems, Increase of energy conversion efficiencies by introducing energy storage.

Operation and Maintenance of Energy Storage Systems: Model of energy storage systems and its management, Electric Vehicle charging facility, Hybrid Energy Storage System (HESS) in micro grid and smart grid, microbial fuel cell, hydrogen fuel cell.

Other Energy Storage Systems and Econometric Analysis of Energy Storage Systems: Performance advantages and disadvantages of lead acid batteries, Inadequacy of existing technologies, Next generation of li-based batteries, Battery Management System (BMS), Electric Vehicles battery considerations. Hybrid Charging (grid and solar photovoltaic). Return on Investment (ROI) and Project Analysis involving Energy Storage Systems.

Text Books:

1. Energy storage devices for renewable energy – based systems by Nihal Kularatna and Kosala Gunawardane, Academic Press by Elsevier -Second Edition 2021.
2. Grid-scale energy storage systems and applications by Fu-Bao Wu, Bo Yang and Ji-Lei Ye , Academic Press by Elsevier -Second Edition 2021.

Reference Books:

1. Energy Storage: Fundamentals, Materials and Applications by Robert A. Huggins; Springer, 2010.

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2. Electric Energy Storage Systems: Flexibility Options for Smart Grids, by Pio Lombardi, PrzemyslawKomarnicki, and Zbigniew Antoni Styczynski, Springer 2017.
3. Energy Storage Systems, by S. Kakac, BirolKilkis, 1989
4. Energy Storage for Sustainable Microgrid, by David Wenzhong Gao, Academic Press Elsevier, 2015.
5. Energy Storage for Power Systems by A.G.Ter-Gazarian, Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.
6. Energy Storage Science and Technology" by A. R. Pendse, SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN - 13:9789380090122), 2011.

Course Outcomes:

Students will able to

EEU722E.1. Explain the different energy storage systems.
EEU722E.2. Apply the electrical efficient energy storage systems.
EEU722E.3. Implement the types of electrical storage systems.
EEU722E.4. Operate and maintain model of energy storage systems.
EEU722E.5. Analyze the economic ways in energy storage systems.

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU722E.1	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU722E.2	2	1	2	1	0	0	0	0	0	0	0	0	2	0	0
EEU722E.3	2	1	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU722E.4	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU722E.5	2	1	2	2	0	0	0	0	0	0	0	0	2	0	0

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EEU723A POWER SYSTEM MODELING

Teaching Scheme: 03 L+ 01TTotal: 04 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

Students will be able to:

I. Study analysis of electromechanical machines

II. Development of mathematical models for synchronous machine

III. Modeling of an induction motor

IV. Understand Parks Transformation

V. Modeling of EHV AC and HVDC and loads

Principle of unified machine theory, generalized torque equation

Performance evaluation of DC machine and speed control

Three phase induction motor- transformation methods, stationary, rotor and synchronous frames and corresponding equivalent circuits.

Three phase synchronous motor: representation, Park transformation

EHV AC and HVDC Transmission line modelling, Modelling of power system loads (Basic load modelling concepts)

Text Books:

l. "Analysis of Electric Machinery", P. C. Krause, McGraw Hill, New York, 1987

2. "Dynamic simulation of Electrical Machinery using Matlab/Simulink",Chee Mun Ong, Prentice Hall PTR,1997 .

Reference Books

1. "Vector Control of A.C. Machines ",P. Vas, Clarendon Press, Oxford ,1990.

2. "Power Electronic Control of AC motors "J .M. D. Murphy and F.G. Turnbull, Pergamum Press, 1988.

3. "Control of Electrical Drives", W. Leonhard, Springer Verlry, 1985.

Course Outcomes:

Students will be able to:

EEU723A.l. Analyze electromechanical devices and, machines

EEU723A.2 Use reference frame theory to study and analyze the behavior of induction and synchronous machines

EEU723A.3 Calculate the machine inductances for use in machine analysis

EEU723A.4 Model the electrical machine from the terminal junction with transmission systems

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU723A.1	2	2	--	1	2	--	--	--	--	--	--	--	1	1	1
EEU723A.2	2	1	--	2	2	--	--	--	--	--	--	--	1	2	2
EEU723A.3	1	3	--	2	2	--	--	--	--	--	--	--	1	3	2
EEU723A.4	1	3	--	2	2	--	--	--	--	--	--	--	2	2	2
EEU723A.5	1	1	--	3	2	--	--	--	--	--	--	--	--	1	3

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EEU723B SMART GRID

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. To study the concept of smart grid.
II. To study Information and Communication technology
III. To study the renewable energy integration

Introduction to Smart Grid: Concept, definitions, difference between conventional and smart grid, challenges in smart grid implementation, Overview of the technologies required for the Smart Grid

Information and Communication Technology: Communication requirements in smart grid, overview of smart grid standards, Wired and wireless communication, Zigbee, Wireless mesh, Cellular Network Communication, Power line Communication, Digital Subscriber Lines, Wi-Max, Wide Area Network, Neighborhood Area Network, and Home Area Network, information technology, cyber security, standards, data handling, interoperability.

Smart Substation: International Electro mechanical Communication 61850 standards and benefits, IEC Generic Object Oriented Substation Event - GOOSE, IEC 61850 Substation model, Intelligent Electronic Devices integration, Substation LAN, WAN, SCADA, Substation automation.

Smart Distribution Systems and Energy Storage: Introduction to Smart Meters, Real time pricing, Smart appliances, Automatic meter reading(AMR), Demand response, Battery storage, Plug in Hybrid electric vehicles, compressed air, pumped hydro, ultra capacitors, fly wheels, fuel cells.

Renewable Energy Integration: Carbon Footprint, Renewable Resources: Wind and Solar, Microgrid Architecture, Modeling Smart Grids 61 PV and wind systems, Tackling Intermittency, Issues of interconnection, protection & control of microgrid, Islanding.

Text Books:

1. Smart Grid Technology and Applications JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama Wiley, March 2012
2. Smart Grids, Jean Claude Sabonnadière, NouredineHadjsaïd, Wiley Blackwell,

Reference Books:

1. Smart Grid: Fundamentals of Design and Analysis, James Momoh, IEEE Press Series on Power Engineering
2. Integration of Green and Renewable Mohammad N. Marwali, Min Dai Wiley, November 2009
3. Smart Grids (Power Engineering) Stuart Borlase CRC Press, October 2012

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Course Outcomes:

On completion of the course, students will be able to:

EEU723B.1. Identify The various aspects of the smart grid, including technologies, components, architectures and applications

EEU723B.2. Understand the issues and challenges involved Analyze different data mining primitives for the functions.

EEU723B.3. Study Current initiatives in the development of smart grid at national and international level implement the different algorithms of classification and prediction.

EEU723B.4. Understand the role of communication and information technology in smart grid Implement the different algorithms for data clustering.

EEU723B.5. Study the micro grid and interconnection issues

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU723B.1	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU723B.2	2	1	2	1	0	0	0	0	0	0	0	0	2	0	0
EEU723B.3	2	1	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU723B.4	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU723B.5	2	1	2	2	0	0	0	0	0	0	0	0	2	0	0

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EEU723C AVANCED MICROPROCESSORS

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Imparting the knowledge about the complete hardware of the advanced microprocessor
II. Imparting the knowledge of the memory management
III. To study Pentium processors

8086 Microprocessor Architecture: Segmented Memory - Addressing Modes - Instruction Set - 8086 Assembly Language Programming - 8087 Numerical Data Processor Architectural details - Data types - Floating point Operations - 8087 Instructions.

Architectural Details of 80386 Microprocessor: Special registers - Memory management - Operation in protected mode and virtual 80386 modes - Memory paging mechanism - Special instructions of 80386 - Architectural details of 80486 - Special registers - Additional instructions - Comparison of 80386 and 80486 processors.

Introduction to Pentium Processor: Architectural features - Comparison with the workstations - Branch prediction logic - cache structure. - Special Pentium Registers. Memory management - virtual mode of operation - Comparison with the previous processors Features of Pentium-II, Pentium-III and Pentium Pro-processors.

RISC Microprocessors : RISC Vs CISC – RISC Properties – DEC Alpha AXP Architecture - Power PC – Architecture - Programming Model – Data Types – Addressing Modes – Instruction Set. Sun SPARC – Architecture – Data Types – Instruction Sets - Features of MIPS, AMD

Text Books:

1. Barry B Brey "Intel Microprocessors : 8086/88, 80186/188, 80286, 80386, 80486, Pentium, Pentium – II, Pentium – III and Pentium – IV, Architecture, Programming & Interfacing", Pearson Education, 2003

Reference Books:

1. Advanced Microprocessors and Interfacing, Badri Ram, Tata McGraw Hill
2. Advanced Microprocessors & Peripherals, A.K. Ray & K.M. Bhurchandi

Course Outcomes:

On completion of the course, students will be able to:

EEU723C.1. Describe the architecture and operation of the 8086, 80386 and RISC microprocessor family.
EEU723C.2. Design interfacing for memory devices to the 8086 and 80386 including dynamic RAM.
EEU723C.3. Design a software system using engineering principles, software engineering and the assembly language

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EEU723C.4. Analyze abstract problems and apply a combination of hardware and software to address the problem

EEU723C.5. Understand concept of multi core processors

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU723C.1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0
EEU723C.2	1	1	2	0	2	0	0	0	0	0	0	0	0	2	0
EEU723C.3	1	1	2	2	0	0	0	0	0	0	0	0	0	2	0
EEU723C.4	1	2	2	2	1	0	0	0	0	0	0	0	0	0	1
EEU723C.5	1	3	0	0	2	0	0	0	0	0	0	0	1	0	0

0- Not correlated 1 - Weakly Correlated 2- Moderately Correlated 3- Strongly Correlated

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EEU723D ALGORITHMS

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objective-

I. Study the asymptotic performance of algorithms.
II. Write rigorous correctness proofs for algorithms.
III. Understand a familiarity with major algorithms and data structures.
IV. Understand important algorithmic design paradigms and methods of analysis.
V. Understand efficient algorithms in common engineering design situations.

Overview of Algorithms: Introduction, Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters' theorem.

Fundamental Algorithmic Strategies: Brute-Force, Greedy, Dynamic Programming, Branch and-Bound and Backtracking methodologies for the design of algorithms; Illustrations
of these techniques for Problem-Solving , Bin Packing, Knap Sack TSP. Heuristics – characteristics and their application domains.

Algorithms Topologies: Graph and Tree Algorithms: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.

Tractable and Intractable Problems: Computability of Algorithms, Computability classes P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems and reduction techniques.

Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE

Text Books:

1. Introduction to Algorithms, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, 4TH Edition, MIT Press/McGraw-Hill.

Reference Books:

1. Algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos, Pearson.
2. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition,
3. Michael T Goodrich and Roberto Tamassia, Wiley.
4. Algorithms 0 A Creative Approach, 3RD Edition, UdiManber, Addison-Wesley, Reading, MA.

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Course Outcomes:

Students will able to

EEU723D.1. Analyze the algorithms.

EEU723D.2. Choose the algorithms strategies.

EEU723D.3. Apply the algorithms topologies.

EEU723D.4. Illustrate the tractable and intractable problem using algorithms.

EEU723D.5. Use the advanced topics in algorithms.

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU723D.1	2	2	1	1	1	0	0	0	0	0	0	0	1	0	0
EEU723D.2	2	1	2	2	2	0	0	0	0	0	0	0	2	0	0
EEU723D.3	1	2	2	1	2	0	0	0	0	0	0	0	1	0	0
EEU723D.4	2	1	2	2	1	0	0	0	0	0	0	0	2	0	0
EEU723D.5	2	2	2	1	1	0	0	0	0	0	0	0	1	0	0

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EEU723 E POWER SYSTEM TRANSIENTS

Teaching Scheme: 03 L+0 T Total: 03 **Credits: 03**

Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**

Duration of ESE: 2hrs.30min

Course Objectives:

Students will be able to understand:

I. Generation of switching transients and their control using circuit

II. Mechanism of lighting strokes and the production of lighting surges.

III. Propagation, reflection and refraction of travelling waves.

IV. Voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

Introduction to Transients:

Importance of the study of transients causes for transients. RL circuit transient with sine wave excitation, basic transforms of the RLC circuit transients. Different types of power system transients, effect of transients on power systems, role of the study of transients in system planning.

Switching Transients:

Over voltages due to switching transients, resistance switching and the equivalent circuit for interrupting the resistor current, load switching and equivalent circuit ,waveforms for transient voltage across the load and the switch , normal and abnormal switching transients. Current suppression, current chopping, effective equivalent circuit. Capacitance switching, effect of source regulation, capacitance switching with a restrike, with multiple restrikes. Illustration for multiple restriking transients, ferro resonance.

Lightning Transients:

Review of the theories in the formation of clouds and charge formation, rate of charging of thunder clouds, mechanism of lightning discharges and characteristics of lightning strokes, model for lightning stroke , factors contributing to good line design, protection using ground wires, tower footing resistance, Interaction between lightning and power system.

Traveling Waves on Transmission Line:

Computation of transients, transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept, step response, Bewely's lattice diagram, standing waves and natural frequencies, reflection and refraction of travelling waves.

Transients in Integrated Power System:

The short line and kilometric fault, distribution of voltages in a power system, Line dropping and load rejection, voltage transients on closing and reclosing lines, over voltage induced by faults, switching surges on integrated system Qualitative application of EMTP for transient computation.

Course Outcomes:

Students will be able to:

EEU723E.Understand and analyze switching and lightning transients.
EEU723E.2 Acquire knowledge on generation of switching transients and their control.
EEU723E.3 Analyze the mechanism of lighting strokes.
EEU723E.4 Understand the importance of propagation, reflection and refraction of travelling waves.
EEU723E.5 Understand the concept of circuit breaker action, load rejection on integrated power system.

Text Books:

1. 'Electrical Transients in Power Systems', Allan Greenwood,Wiley Inter Science, New York, 2ndEdition, 1991.
2. "Electromagnetic transients in Power System",PritindraChowdhari, John Wiley and Sons Inc., Second Edition, 2009.
3. 'Power System Transients – A statistical approach'C.S. Indulkar, D.P.Kothari, K. Ramalingam, PHI Learning Private Limited, Second Edition, 2010.

Reference Books:

1. M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', McGraw Hill, Fifth Edition, 2013.
2. R.D. Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Limited, 1986.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU723E.1	2	2	0	1	2	0	0	0	0	0	0	0	1	1	1
EEU723E.2	2	1	0	2	2	0	0	0	0	0	0	0	1	2	2
EEU723E.3	1	3	0	2	2	0	0	0	0	0	0	0	1	3	2
EEU723E.4	1	3	0	2	2	0	0	0	0	0	0	0	2	2	2
EEU723E.5	1	1	0	3	2	0	0	0	0	0	0	0	0	1	3

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EEU733 A FUNDAMENTAL OF ELECTRICAL DRIVES

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. To introduce the basic concepts of electrical machines and drives.
II. To explicate different performance characteristics of AC and DC motor.
III. To initiate studies in solid state control of AC and DC motors
IV. To comprehend procedure for selection of motor for different applications

Concept of General Electric Drives: Classification and comparison of electric drive system, cooling and heating of electric motors, Theory and working principle of power transistors, power MOSFET, SCR.

Basic Characteristics of DC Motors: Torque equation, modified speed–torque characteristics, starting and braking of electric DC motors, comparison of mechanical and electric braking methods, conventional speed control methods.

Classification of AC Motors: Construction, types, characteristics of 3-phaseIM, torque equation, applications, staring and braking of 3-phase IM, conventional speed control methods. Thyristorised stator voltage control of 3-phase IM, (V/F) control, slip–power recovery scheme, thyristorised armature voltage control of DC motors using phase control and thyristorised chopper.

Introduction, principle, construction and working of DC servo motors, stepper motors, brushless DC motors, classification of 1-phase IM, construction, principle, working and applications, principle and working of Universal motor, linear IM

Industrial Applications: Classes of duty, selection of an electric drive for particular applications such as steel mill, paper mill, cement, textile mill, electric traction, coal mining, etc.

Text Books:

1. Electric machines, I.J. Nagrath and D.P.Kothari, 2nd Edn, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi, 2008.
2. Electrical Technology (AC and DC drives) Vol-II and Vol-III B.L .Thereja, 4th Edn. Dhanpat Rai and Sons, 2002.

Reference Books:

1. Electric Motor Drives-modeling, analysis and control, R. Krishnan, 1st Edn, Pearson Edu, 2006.
2. Utilization of Electrical Power, R.K. Rajput, 5thEdn, Laxmi publications, 2007
3. Fundamentals of Electrical Drives, G. K. Dubey, Narosa Publishing House, 2005

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Course Outcomes:

On completion of the course, students will be able to:

EEU733.A.1 Understand the basic concepts of electric drives.

EEU733.A.2 Present different performance characteristics of AC and DC motors.

EEU733.A.3 Describe solid state controls for AC and DC motors

EEU733.A.4 Portray construction and working of different modern electric machines.

EEU733.A.5 Select motors for different applications

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU733.A.1	1	2	0	0	0	0	0	0	0	0	0	0	1	1	0
EEU733.A.2	1	2	0	0	0	0	0	0	0	0	0	0		2	0
EEU733.A.3	0	3	0	1	0	0	0	0	0	0	0	0	1	1	0
EEU733.A.4	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
EEU733.A.5	0	0	0	1	2	0	0	0	0	0	0	0	0	1	0

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EEU733 B ELECTRICAL ESTIMATING AND COSTING

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**

Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**

Duration of ESE: 2hrs.30min

Course Objectives:

I. To summarize the importance of estimation, specification and earthing.

II. To prepare the schedule of materials with specifications and estimates for service mains.

III. To enable the students to prepare the schedule of materials with specifications and estimates for different types of electrical installations.

Introduction: Meaning of estimation, purpose of estimating and the factors to be considered while preparing estimations, qualities of a good estimator, Meaning of specification, importance of specification and the factors to be considered. Meaning of standardization and its advantages. Meaning of overhead charges, stock incidental charges, contingencies, supervision charges, labour charges, Inspection/Inspectorate charges, transportation charges and miscellaneous charges. Meaning of tender/tender notice, quotation, comparative statement, purchase order and work order. Importance / purpose of IE Act and IE Rules. Meaning of earthing, touch potential and step potential, necessity of earthing, Points to be earthed, factors influencing earth resistance, methods of reducing earth resistance, standard values of earth resistance for various installations, method of selecting the size of earth conductor, types /methods of earthing, Pipe earthing-diagram, specifications of pipe earthing, Plate earthing-diagram and specifications of plate earthing.

Service Mains: Meaning of service mains, code of Practice for service mains, types of service mains- Over Head Service Mains -materials and specifications, UG Service Mains - materials and specifications, Standard wire size table, current ratings for Aluminum, copper conductors and selection of size of conduit pipe as per the size and number of wires. Load calculation, selection of size and type of conductor/UG cable, discrimination of size of protective devices, Quantity calculation, schedules of materials and estimates for single phase OH service connection, three phase OH service connection, single phase UG service connection and three phase UG service connection

Lighting Installations: Interior Wiring types and their applications, factors to be considered while selecting the type of wiring system, materials required for Interior wiring and their specifications, Code of Practice for Lighting Installations, method of deciding the number of sub-circuits, calculating the quantity of wiring materials and accessories for the Interior Wiring, load calculations for a residential buildings, size of conductors, main switch, sub switches and protective devices. Draw wiring plan for AEH Installation, concept of horizontal run, vertical rise and vertical drop. Prepare the schedule of materials for providing lighting and heating circuits and their estimates. Procedure for converting lighting to AEH installation

Power Installations: Code of Practice for Power Installations, materials required for power circuit wiring and their specifications, Prepare the layout diagram of machines showing clearances as per IS standards, draw wiring plan of the Power circuit for workshops, Decide the type of wiring.

system, load calculations, determine the size of conductors, main switch, Isolators, sub switches and protective devices, Draw the SLD of Power Distribution Scheme showing grading/discrimination of ratings of protective devices, Prepare the schedule of materials with specifications for workshops and their estimates, Determine the rating of motor for IP set and the concept (only)of pump house wiring.

Distribution Lines and Transformer Substations: Code of practice for Distribution Lines and Transformer centre, types of transformer centres - Pole mounted, plinth mounted, indoor and outdoor types. Determining the rating of Distribution Transformer. Write Specifications of the Distribution Transformer. Draw the SLD of a Transformer centre indicating the size of protective devices, Prepare the schedule of equipments /Materials with specifications for a 11KV/415V,100 KVA transformer centre and their estimates, 415 V LT line materials and specifications , method of calculating various LT line materials (only). Prepare the schedule of materials (only) for 3 phase 4 wire LT line, 11 KV HT Line-materials and their specifications, method of calculating various HT line materials and tapping structure, TOPO sheet and its use, Concept of combined estimates. Prepare the schedule of materials (only) for 11 KV single circuits. HT line for Rural Electrification.

Transmission Lines and Substations: Code of practice for Transmission lines and substations, transmission line materials and their specifications, types of Towers, ACSR conductors and Number of Disc insulators in suspension string, strain string, span and height of towers for 66 KV, 110 KV, 220 KV transmission lines, concept of single circuit and double circuit transmission lines, method of calculating the Quantity of transmission line materials, Prepare the schedule of materials (only) for 66 KV,110 KV and 220 KV single circuit transmission lines. 66KV/11KV, 5 MVA Substations- Single Line diagram, list of Electrical equipments/ materials (only) and their specifications.

Text Books:

1. Electrical Design Estimating and Costing, Raina.K.B.& Bhattacharya. S.K. New Age International

Reference Books:

1. A Course in Electrical Installation, Estimating & Costing, J B Gupta, S K Kataria& Sons.
2. Electrical estimating and costing, Surjith Singh, Danpat Rai &Co.

Course Outcomes:

On completion of the course, students will be able to:

EEU733B.1 Understand various types of materials required for wiring.
EEU733B.2 Comprehend the estimation of a domestic installation.
EEU733B.3 Know different systems of earthing.
EEU733B.4 Comprehend the estimation of industrial installations.
EEU733B.5 Comprehend the estimation of substations.

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CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU733B.1	2	0	0	0	0	0	0	0	0	0	0	0	2	1	0
EEU733B.2	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0
EEU733B.3	3	3	2	2	2	0	0	0	0	0	0	0	2	2	0
EEU733B.4	2	3	0	1	2	0	0	0	0	0	0	0	2	2	0
EEU733B. 5	2	1	0	0	0	0	0	0	0	0	0	0	1	1	0

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EEU725A HVDC AND FACTS

Teaching Scheme: 03 L+0 T Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:
Students will be able to:
I . To learn the active and reactive power flow control in power system
II. To understand the need for static compensators'
III. To develop the different control strategies used for compensation

Introduction to HVDC:
Introduction of DC Power transmission technology – Comparison of AC and DC transmission, Application and Description of DC transmission system, planning for HVDC transmission, Modern trends in DC transmission, Types of HVDC Systems.

Analysis of HVDC Converters:
Pulse Number-Choice of converter configuration, simplified analysis of Gratez circuit, 12-pulse converter based HVDC systems and their characteristics, Control of Converters.

Harmonics and Filters:
Introduction – Generation of Harmonics, Design of AC filters and DC filters, HVDC light and HVDC PLUS (Power Universal Link), Series and Parallel operation of converters.

Introduction to FACTS:
The concept of flexible AC transmission – reactive power control in electrical power transmission lines, uncompensated transmission line, Introduction to FACTS devices and its importance in transmission Network, Introduction to basic types of FACTS controllers, Comparison of HVDC and FACTS.

FACTS Controllers:
Principles of series and shunt compensation, description of static var compensators (SVC), thyristor controlled series compensators (TCSC), static phase shifters (SPS), static synchronous series compensator (SSSC), STATCOM.

Text Books:

l." HVDC Power Transmission System", K. R. padiyar, Wiley Eastern Limited, New Delhi , First Edition1990.
2. "Understanding FACTS:Concepts and Technology of FACTS'Systems", N.G.Hingorani, IEEE Press,2000

Text Books :

1. " Reactive Power Control in Electrical System", T.J.E. Miller, John Wiley and Sons, New York, 1982.

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2. "FACTS Controller in Power Transmission and Distribution", K.R. Padiyar New Age International (P) Ltd,2007.

References Books:

1. " High voltage Direct Current Transmission", J. Anillaga, Peter Pregnnus, London 1983.
2. http://www.nptel.iitm.ac.in
3. www.ocw.mit.edu

Course Outcomes:

On completion of the course the students will be able to:

EEU725A.1 Analyze the different control strategies for power flow using HVDC devices.

EEU725A.2. Understand the working of different HVDC Converters

EEU725A.3.Study the working of Harmonics & filters

EEU725A.4 Understand the concept of FACTS.

EEU725A.5 Develop analytical modeling and analysis FACTS Controllers.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU725A.1	2	2	1	1	2	1	1	0	0	0	0	0	1	1	1
EEU725A.2	2	2	0	2	2	0	0	0	0	0	0	0	1	2	2
EEU725A.3	2	3	0	2	2	0	0	0	0	0	0	0	1	3	2
EEU725A.4	2	3	1	2	2	1	0	0	0	0	0	0	2	2	2
EEU725A.5	2	2	0	3	2	0	0	0	0	0	0	0	0	1	3

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EEU725B POWER QUALITY ISSUES & MITTIGATION

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives-

I. To study the power quality problems in distributed systems.
II. To understand the compensation techniques.
III. To identify the filter types to mitigate power quality problems.

Basic Concepts of Power Quality: Power quality problems in distribution systems, definitions, power quality standards, Harmonics, Harmonic creating loads & its modeling

Passive Shunt and Series Compensation: Introduction, State of The Art on Passive Shunt and Series Compensators, Classification of Passive Shunt and Series Compensators, Principle of Operation Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators.

Active Shunt Compensation: Introduction, State of the art on DSTATCOM, Classification of DSTATCOM, Principle of operation and control of DSTATCOM, Analysis and Design of DSTATCOM.
Active Series Compensation: Introduction, State of the art on Active Series Compensators, Classification of Active Series Compensators, Principle of Operation of Active Series Compensators, Analysis and Design of Active Series Compensators.
Mitigation of Power Quality Problems: Harmonics Propagation, Series and Parallel Resonance, Harmonic Power Flow, Mitigation of Harmonics, Filters, Active Filters, Shunt and Series Hybrid Filters.

Text Books:

1. "Electrical Power Systems Quality", Dugan Roger, McGraw-Hill Edition 2002.
2. "Power quality problems and mitigation techniques", Bhim Singh, Ambrish Chandra and Kamal-Al-Haddad, Wiley Edition 2015.

Reference Books:

1. "Electric power quality", G.T. Heydt McGraw-Hill Professional, 2007.
2. "Understanding Power Quality Problems", Math H. Bollerr IEEE Press, 2000.

Course Outcomes:
Students will able to study-

EEU725B.1. Define the power quality problem in distribution systems.
EEU725B.2. Illustrate the comparative analysis in passive shunt and series compensation.
EEU725B.3. Analyze the active shunt compensation technique.
EEU725B.4. Explain the active series compensation technique.

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EEU725B.5. Formulate the different types of filter to mitigate power quality issues.

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU725B.1	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU725B.2	2	2	1	2	0	0	0	0	0	0	0	0	2	0	0
EEU725B.3	2	1	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU725B.4	2	2	1	1	0	0	0	0	0	0	0	0	2	0	0
EEU725B.5	1	2	2	2	0	0	0	0	0	0	0	0	2	0	0

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EEU725 C DIGITAL CONTROL SYSTEM

Teaching Scheme: 03 L + 00 T **Total: 03 Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min

Course Objectives:

I. To understand digital control the systems with nonlinear behaviours.
II. To learn fundamentals and applications of digital control for multidisciplinary engineering problems.
III. To develop mathematical models for controlling system

Discrete Representation of Continuous Systems:

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Discrete System Analysis:

Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.

Stability of Discrete Time System:

Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

State Space Approach for Discrete Time Systems:

State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

Design of Digital Control System:

Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Discrete Output Feedback Control:

Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

TextBooks:

1. K. Ogata, “Digital Control Engineering”, Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, “Digital Control Engineering”, Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, “ Digital Control of Dynamic Systems”, Addison-Wesley, 1998.
4. B.C. Kuo, “Digital Control System”, Holt, Rinehart and Winston, 1980.

Reference Books :

1. Hemchandra Madhusudan Shertukde, "Digital Control Applications Illustrated with MATLAB" 2015, CRC Press

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2. Zito Landau, "Digital Control Systems : Design, Identification and Implementation, 1/E", Springer-Verlag
3. V. I. George, C.P. Kurian, “Digital Control Systems 1/E", Cengage Learning
4. Kavita Singh, Rashmi Vashisth, "Digital Control System", Galgotia Publications
5. http://www.nptel.iitm.ac.in/
6. www.ocw.mit.edu

Course Outcomes:

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

EEU725C.1. Obtain discrete representation of LTI systems.
EEU725C.2. Analyze stability of open loop and closed loop discrete-time systems
EEU725C.3. Design and analyze digital controllers.
EEU725C.4. Design state feedback and output feedback controllers.
EEU725C.5. Learn fundamentals of intelligent/smart control systems used for industrial automation.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU725C.1	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0
EEU725C.2	2	1	0	1	2	0	0	0	0	0	0	0	2	2	2
EEU725C.3	1	3	0	1	2	0	0	0	0	0	0	0	1	0	0
EEU725C.4	2	1	2	2	0	0	0	0	0	0	0	0	1	0	0
EEU725C.5	1	2	0	0	3	0	0	0	0	0	0	0	1	2	

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EEU725D COMPUTER NETWORK

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Develop an understanding of modern network architectures from a design and Performance perspective.
II. Introduce the student to the major concepts involved in wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs).
III. Provide an opportunity to do network programming
IV. Provide a WLAN measurement ideas.

Data Communication Components: Representation of data and its flow Networks,, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth Utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD,CDMA/CA

Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography.

Text Books:

1. Data Communication and Networking, Behrouz A. Forouzan, 4th Edition, McGraw-Hill.
2. Data and Computer Communication William Stallings, , 8th Edition, Pearson Prentice Hall India.

Reference Books:

1. Computer Networks, Andrew S. Tanenbaum, 8th Edition, Pearson New International Edition.

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2. Internetworking with TCP/IP Douglas Comer, Prentice, Volume 1, 6th Edition Hall of India.
3. TCP/IP Illustrated W. Richard Stevens, Addison-Wesley, , Volume 1, United States of America.

Course Outcomes:

EEU725D.1 Explain the functions of the different layer of the OSI Protocol.
EEU725D.2 Draw the functional block diagram of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) describe the function of each block.
EEU725D.3 Design a given requirement (small scale) of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) based on the market available component
EEU725D.4 Developed the network programming for a given problem related TCP/IP protocol.
EEU725D.5 Configure DNS DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU725D.1	2	2	1	2	1	0	0	0	0	0	0	0	0	0	0
EEU725D.2	2	2	2	1	1	0	0	0	0	0	0	0	0	0	0
EEU725D.3	2	1	2	2	1	0	0	0	0	0	0	0	0	0	0
EEU725D.4	2	2	1	2	2	0	0	0	0	0	0	0	0	0	0
EEU725D.5	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0

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EEU725E POWER SYSTEM PLANNING AND DESIGN

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. To study the concept of power system planning.
II. To design EHV lines
III. To study the insulation coordination

Transmission lines design : Requirements of transmission lines, selection of voltage for high-voltage transmission lines, choice of conductors, spacing of conductors, corona, insulators, specifications of transmission lines, surge impedance loading of transmission lines, electrical design of transmission lines, main considerations in the mechanical design of transmission lines, sag-tension relation, stringing of transmission lines, towers Design of **EHV transmission lines :** transmission of electric power at extra high voltage, design considerations of EHV lines, selection and spacing of conductors, corona, radio and television interference, insulation coordination, towers

Design of distribution systems: Development of a distribution plan, transmission and distribution systems, types of distribution systems arrangements, primary distribution design, secondary distribution design distribution substations, calculation of distributor sizes: voltage drops, voltage regulation, Lamp flicker.

Design of power system: Introduction, selection of sizes and location of generating stations, selection and specifications of transmission lines, sizes and location of substations, interconnection

Power System Earthing : Objectives, definitions, tolerable limits of body currents, soil resistivity, earth resistance, tolerable step and, actual step and touch voltage, design of earthing grid, concrete encased electrodes, tower footing resistance, measurement of earth resistance R, measurement of soil resistivity, impulse behavior of earthing system.

Insulation Co-ordination: Introduction, definitions, determination of line insulation, B.I.L and insulation levels of sub-station equipment, lightning arrester selection, power system over voltages, tentative selection of arrestor voltage ratings, selection of arrestor discharge currents, arrestor discharge voltage, establishment of impulse voltage level of equipment, protective margin, establishment of separation limits, location of lightening arrestor.

Power system improvement: Introduction, methods of power system improvement, power system improvement scheme, determination of the voltage regulation and losses in a power system, shifting of distribution transformer centre, financial aspects of the power system improvement scheme.

Power system planning: Introduction, methods of power system planning, forecasting load and energy requirements, generation planning, transmission system planning, distribution

system planning, reliability of electrical power systems, methods of measuring power system reliability

Text Books:

1. Electrical Power System Design – B. R. Gupta, S. CHAND
2. Electrical Power System Design – M. V. Deshpande, TMH publication

Reference Books:

1. A course in Electrical Power- Soni, Gupta and Bhatnagar, Dhanpat Rai& Sons
2. Substation Design – Satnam & Gupta, Dhanpat Rai andCo.
3. Electrical Power System Planning – A. S. Pabla, TMHpublication

Course Outcomes:

On completion of the course, students will be able to:

EEU725E.1. Identify the various aspects of the smart grid, including technologies, components, architectures and applications

EEU725E.2. Understand the issues and challenges involved Analyze different data mining primitives for the functions.

EEU725E.3. Study Current initiatives in the development of smart grid at national and international level implement the different algorithms of classification and prediction.

EEU725E.4. Understand the role of communication and information technology in smart grid Implement the different algorithms for data clustering.

EEU725E.5. Study the micro grid and interconnection issues

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU725E.1	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU725E.2	2	1	2	1	0	0	0	0	0	0	0	0	2	0	0
EEU725E.3	2	1	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU725E.4	2	2	2	2	0	0	0	0	0	0	0	0	2	0	0
EEU725E.5	2	1	2	2	0	0	0	0	0	0	0	0	2	0	0

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EEU726 ENERGY MANAGEMENT

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**

Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**

Duration of ESE: 2hrs.30min

Course Objectives:

I. To understand various energy management techniques.
II. To understand energy auditing techniques.
III. To familiarize with energy related policies.

Energy Basics: Energy Demand Management, Conservation & Resource Development, Energy for Sustainable Development.

Need for Energy Management by Sector: Industry, Buildings & Houses, Transport, Electric Power. Need for Energy Management by Sector- Agriculture, Domestic; Energy forecasting techniques; Energy Integration, Energy Matrix.

Energy Auditing: Energy management for cleaner production, application of renewable energy, appropriate technologies.

Modeling techniques for supply and demand: Market structure, transportation models, game theory, futures markets, environmental issues, energy policy, energy regulation, input/output models.

Text Books:

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific

References Books

1. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
2. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988
3. Energy Management Principles, C.B.Smith, Pergamon Press

Course Outcomes:

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

EEU726.1. Become efficient energy managers.
EEU726.2. Know different energy auditing methods.
EEU726.3. Suggest energy saving methods.
EEU726.4. Develop techniques for supply and demand.
EEU726.5. Prepare moelling by sector.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU726.1	3	-	-	-	-	-	-	-	-	-	-	-	2	1	-
EEU726.2	3	1	2	-	-	-	-	-	-	-	-	-	2	3	-
EEU726.3	2	3	2	2	1	-	-	-	-	-	-	-	3	2	-
EEU726.4	2	3	2	2	1	-	-	-	-	-	-	-	2	2	-
EEU726.5	3	2	-	1	-	-	-	-	-	-	-	-	1	1	-

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EEU821A POWER SYSTEM DYNAMICS AND STABILITY

Teaching Scheme: 03 L+ 00T Total: 03 **Credits: 03**

Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**

Duration of ESE: 2hrs.30min

Course Objectives:

I. To Provide In-depth understanding of different aspects of Extra High Voltage AC transmission system design and Analysis.
II. To understand the concept of Voltage gradients of conductors.
III. To understand the Electrostatic field and its effects over humans, animal and plants.

Basics of Power System Stability: Concept of stability, types of stability, modeling of power system components for stability studies, power system dynamics, swing equation, factors affecting stability and recent trends for improving stability

Small Disturbance Stability: Steady state stability of two-machine system, power angle curve, stability criterion, definition and computation of SSSL by analytical and graphical methods, effect of inertia, saliency, saturation, governor action and SCR on SSSL

Large Disturbance Stability: Single machine infinite bus (SMIB) system, classical model, equal area criteria technique and its applications to various types of disturbances, point by point method or solving swing equation

Excitation System: Effect of excitation system on generator power limit, various types of excitation systems, transformation model of excitation system

Text Books:

1. Power System Analysis, Hadi Sadat, Tata McGrawHill,2005
2. Modern Power System Analysis, Nagrath and Kothari, Mc Graw Hill, 2005
3. Power System stability and Control, P.Kundur, Mc GrawHill, NewYork,2007

References Books

1. Power System Stability, E.W. Kimbark, Vol 1 and3,Dover Publications 1999
2. Power System Dynamics, Stability and Control, K.R. Padiyar Interline Publishers, Bangalore,2007
3. Power System Control and Stability, P.M Anderson and A.A.Fouad, Mc Graw Hill, 2004
4. http://www.nptel.iitm.ac.in/
5. www.ocw.mit.edu

Course Outcomes:

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

EEU821A.1 Interpret the basic concept of power system stability.
EEU821A.2 Model the power system components for stability studies.

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EEU821A.3 Apply different methods for analyzing steady state stability of a two machine system.

EEU821A.4 Asses the transient stability using equal area criterion and Point by Point method.

EEU821A.5 Describe the various types of excitation systems and its effect on generator power limit.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU821A.1	3	-	-	-	-	-	-	-	-	-	-	-	2	1	-
EEU821A.2	3	1	2	-	-	-	-	-	-	-	-	-	2	3	-
EEU821A.3	2	3	2	2	1	-	-	-	-	-	-	-	3	2	-
EEU821A.4	2	3	2	2	1	-	-	-	-	-	-	-	2	2	-
EEU8221A.5	3	2	-	1	-	-	-	-	-	-	-	-	1	1	-

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EEU727 ELECTRICAL DRIVES AND CONTROL LAB

Teaching Scheme: 02 P Total: 02 **Credit: 01**
Evaluation Scheme: 25 ICA + 25 ESE **External Total Marks: 50**
Duration of ESE: 3 Hrs.

Course Objectives:

I. Understand the concept of soft starting
II. Test the characteristics of DC and AC drives.
III. Explore the software's for simulation

It is representative list of practicals. The instructor may choose experiments as per his requirements (so as to cover entire contents of the course) from the list or otherwise. Minimum eight experiment should be performed.(The laboratory may consist of 2-3simulation studies based on Matlab-Simulink/ PSIM/ PSPICE platform and one industrial visit for study of electrical drive.)

Representative List:

1. Converter controlled dc motor.
2. Chopper controlled dc motor.
3. Stator voltage controlled induction motor.
4. Stator frequency controlled induction motor.
5. Plugging/ rheostatic braking of dc motor.
6. Plugging/rheostatic braking of induction motor.
7. Study of solid state / soft starters for electrical motors.
8. Study of electrical drive in any industry.(Industrial visit)
9. Simulationof1/2/ 4 quadrants Converter controlled dc drive.
10. Simulation of 1/2/4 quadrant Chopper controlled dc drive
11. Simulation of open loop / closed loop V/f control of I.M.
12. Simulation of rotor chopper control of I.M.

Note:-
ICA- Internal Continuous Assessment shall be based on the practical record and knowledge/skills acquired. The performance shall assess experiment wise by using continuous assessment formats, A and B.
ESE- The End Semester Exam for practical shall be based on performance in one of Experiments and may be followed by sample questions

COURSE OUTCOMES:

EEU727.1. Understand the control strategies for dc/ac motor
EEU727.2. Verify the different methods of braking for dc/ac motors
EEU727.3. Verify the performance of dc/ac drives through simulation

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CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU727.1	2	1	-	-	-	-	-	-	-	-	-	-	2	2	-
EEU727.2	2	2	1	-	2	-	2	-	-	-	-	-	3	2	-
EEU727.3	2	2	1	1	2	1	-	-	-	-	-	2	3	1	-

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EEU821B WIND AND SOLAR SYSTEMS

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. Appreciate the importance of renewable energy sources.
II. Demonstrate the knowledge of the generation aspects of wind power and issues for grid integration.
III. Demonstrate the knowledge of solar power generation and the associated

Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power - cumulative distribution functions, site selection and layout of wind farm.

Smart Transmission System: Phasor Measurement unit, Phasor data concentrators, Wide area measurement control and protection, Wide area measurement systems and its applications, Flexible Alternating Current Transmission Systems. High-voltage Direct-current Transmission

Network Integration Issues: Overview of grid code technical requirements for wind farms - real and reactive power regulation, voltage and frequency operating limits, wind farm behavior during grid disturbances, power system interconnection experience in the world, Economic aspects, Hybrid and isolated operations of wind farms.

The Solar Resource Introduction: solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Solar Photovoltaic Technologies: Amorphous, mono crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Maximum Power Point Tracking (MPPT) algorithms.

Solar Thermal Power Generation Technologies: Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis, prospects for India.

Text Books:

1. Renewable and Efficient Electric Power Systems, Gilbert M. Masters John Willy and sons, 2004, ISBN0-471-28060-7.
2. Solar Energy S.P. Sukhatme Tata McGrew Hill, second edition, 1996, ISBN 0-07-462453-9

Reference Books:

1. Wind Power in Power Systems, Thomas Ackermann, Editor John Willy and son's ltd., 2005, ISBN 0- 470-85508-8.
2. Grid integration of wind energy conversion systems Siegfried HeierJohn Willy and sons ltd.2006
3. Renewable Energy Applications Mullic and G.N.Tiwari Pearson Publications.

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Course Outcomes:

On completion of the course, students will be able to:

EEU821B.1. Identify and apply the data warehouse and OLAP technology for data mining.
EEU821B.2. Understand the data preprocessing issues and data mining functions.
EEU821B.3. Analyze different data mining primitives for the functions.
EEU821B.4. Implement the different algorithms of classification and prediction.
EEU821B.5. Implement the different algorithms for data clustering.

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU821B.1	3	-	-	-	-	-	-	-	-	-	-	-	2	1	-
EEU821B.2	3	1	2	-	-	-	-	-	-	-	-	-	2	3	-
EEU821B.3	2	3	2	2	1	-	-	-	-	-	-	-	3	2	-
EEU821B.4	2	3	2	2	1	-	-	-	-	-	-	-	2	2	-
EEU821B.5	3	2	-	1	-	-	-	-	-	-	-	-	1	1	-

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EEU821C Electric and Hybrid Electric Vehicles

Teaching Scheme: 03 L+ 01T Total: 04 **Credits: 03**

Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**

Duration of ESE: 2hrs.30min

Course Objectives:

Students will be able to:

I. To understand upcoming technology of hybrid system
II. To understand different aspects of drives application
III. Learning the electric Traction

History of Hybrid and Electric Vehicles: Social and environmental importance of hybrid and electric vehicles. Impact of modern drive/trains on energy supplies, Basics of vehicle performance, vehicle power source characterization, Transmission characteristics,

Basic Concept of Hybrid Traction: introduction to various hybrid drive-train topologies, Power flow control in hybrid drive/train topologies, Fuel efficiency analysis.

Introduction to Electric Components used in Hybrid and Electric Vehicles: Configuration and control of DC Motor drives, Configuration and control of Permanent Magnet Motor drives Configuration and control of Switch, Reluctance. Motor drives

Matching the Electric Machine and the Internal Combustion Engine (lCE): Sizing the propulsion motor, Sizing the power electronics, selecting the energy storage technology Communications, and Supporting subsystems.

Introduction to Energy Management and their Strategies used in Hybrid and Electric Vehicle: Classification of different energy management strategies, Comparison of different energy management strategies, Implementation issues of energy strategies

Text Books:

l. "Control Design Techniques in Power Electronics Devices", Sira -Ramirez, R. Silva Ortigoza Springer.

2, "Sliding mode control of switching Power Converters". Siew-Chong Tan, Yuk-Ming Lai, Chi Kong' Tse

3. “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives” Chris Mi, M. Abul Masrur, David Wenzhong Gao,, 2011, Wiley publication.

Reference Books:

1. “Hybrid Vehicles and the future of personal transportation” Allen Fuhs, 2009, CRC Press.
2. “Electric Vehicle Technology Explained” James Larminie, John Lowry,, 2003, Wiley publication.

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Course Outcomes:

At the end of this course students will understand:

EEU821C.1 Concept of Electric Vehicles, Hybrid Electric Vehicles & Plug in Hybrid Electric vehicles

EEU821C.2 Concept of hybrid traction

EEU821C.3Application of Power electronics and electric components used in hybrid and electric vehicles

EEU821C.4Matching the electric machine and the internal combustion engine

EEU821C.5 Energy management and their strategies used in hybrid and electric vehicle

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU821C.1	2	2	1	1	2	1	1	0	0	0	0	0	1	1	1
EEU821C.2	2	2	0	2	2	0	0	0	0	0	0	0	1	2	2
EEU821C.3	2	3	0	2	2	0	0	0	0	0	0	0	1	3	2
EEU821C.4	2	3	1	2	2	1	0	0	0	0	0	0	2	2	2
EEU821C.5	2	2	0	3	2	0	0	0	0	0	0	0	0	1	3

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EEU821D CYBER SECURITY

Teaching Scheme: 03 L Total: 03 **Credits: 03**
Evaluation Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE: 2hrs.30min

Course Objectives:

I. To Define the need of Cyber Security
II. Understand the broad set of technical, social & political aspects of Computer Security
III. Identify the Cyber Crime Investigation Methodology.

Introduction: Nature and scope of computer crime, Understanding how cyber criminals and hackers work, Different types of cyber-crimes, Introduction to digital signatures, Cryptography, Digital certificate and public key infrastructure, IT Act., Impact of cyber-crime on e-governance and e-commerce

Malware Reverse Engineering: Overview of malware reverse engineering, Types of malware, malicious code families, Latest trends in malware analysis, Basic static and dynamic analysis, Malware analysis techniques, Case study

Web Application Security: Introduction to web application security: Attacks, vulnerabilities and mitigation, Client-side security, Server-side security, Application security: HTTPS, HSTS etc., Security engineering: Passwords and their limitations, Attacks on passwords: CAPTCHA, OTP

Advanced Security Topics: Secure Email Systems: PGP, SMIME, DKIM, DMARC, DNSSec, SMTP STS etc., Privacy and security for online social networks, Database security, Browser security, Mobile device security

Ethical Hacking and Penetration Testing: Security Technologies: IDS, IPS, Ethical hacking, Penetration testing fundamentals: Reconnaissance, scanning, gaining access, maintaining access, Covering tracks

Text Books:

1. Handbook of Information Security, Threats, Vulnerabilities, Prevention, Detection, and Management Algorithms, Hossein , Wiley, Volume 3 edition, ISBN-13: 978-0470323069.
2. Penetration testing: A Hands-On Introduction to Hacking ,Georgia Weidman No Starch Press, 2014, ISBN-13: 978-1593275648
3. Practical Malware Analysis, Michael Sikorski and Andrew Honig, No Starch Press, 1st Edition, 2012, ISBN-13: 978-1593272906

Reference Books:

1. Practical Internet of Things Security by Brian Russell, Drew Van Duren, Packet publishing, 2016, ISBN: 9781785889639

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2. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, T. Mather, S. Kumaraswamy, S. Latif, O'Reilly Series, 2009, ISBN-13: 978-0596802769.
3. Cyber law: the Indian perspective, Pavan Duggal; Saakshar Law Publications, 1st edition, 2002, ISBN: 8189121022, 9788189121020.

Course Outcomes:

On completion of the course, students will be able to:

EEU821D.1. Demonstrate the knowledge of penetration testing, and social networking security.
EEU821D.2. Analyze the malwares, social networking websites and impact of cyber-crime on ecommerce
EEU821D.3. Explain the IT act, Application Security vulnerabilities and its mitigation techniques
EEU821D.4. Describe the operational and organizational security Aspects
EEU821D.5. Explain Authentication Methods

CO – PO –PSO Mapping:

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU821D.1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0
EEU821D.2	1	1	2	0	2	0	0	0	0	0	0	0	0	2	0
EEU821D.3	1	1	2	2	0	0	0	0	0	0	0	0	0	2	0
EEU821D.4	1	2	2	2	1	0	0	0	0	0	0	0	0	0	1
EEU821D.5	1	3	0	0	2	0	0	0	0	0	0	0	1	0	0

0- Not correlated 1 - Weakly Correlated 2- Moderately Correlated 3- Strongly Correlated

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EEU821E ADVANCED DRIVES

Teaching Scheme: 03 L + 00 T Total 03 **Credit: 03**
Marking Scheme: 30 MSE +10 TA+ 60 ESE **Total Marks: 100**
Duration of ESE : 2 Hrs.30 min.

Course Objectives:

I. To impart knowledge about fundamentals of Electric drives and control
II. To acquire the knowledge of selection of drives as per practical operational industrial requirement.
III. To apply their knowledge to prepare control schemes as per different types of motors used in industries.

Review of Electric Drives: Classification, Comparison of AC and DC drives, Basic elements, Torque equation, Multi-quadrant operation, Equivalent values of drive parameters, components of load torque, Stability consideration, closed loop control of drives, Thermal model of motor for Heating and Cooling, Classes of Duty.

DC Drives: Half controlled, full controlled and dual converter based separately excited dc motor drives and their analysis. Effect of source and load inductance. DC-DC converter (Chopper) fed dc series motor drives and its steady state analysis.

Induction Motor Drives: Review of induction motor equivalent circuit, Effect of voltage, frequency and stator current on performance of the machine, effect of harmonics, harmonic equivalent circuit, dynamic d-q model, derivations of commonly used induction motor models, scalar control of induction motor.

Synchronous Motor Drives: Review of synchronous motor fundamentals, equivalent circuit, Dynamic d-q model, and Synchronous motors variable speed drives.

Special Drives: Brushless / Commutator less dc motor drives: Configuration, modes of operation and analysis. Switched Reluctance motor drives: Configuration, converters, modes of operation and analysis.

Special Topics: Measures of energy conservation in electrical drives. Introduction to the fundamental principles of torque controlled and sensor less drives, Vector controlled and direct torque controlled induction motor drives.

Text Books:

1. Fundamentals of Electrical Drives by G. K. Dubey Narosa Publishing House, 1995.
2. Electric Motor Drives: Modeling, Analysis and Control R. Krishnan Pearson Edu.,1998
3. Modern Power Electronics and AC Drives by B.K.Bose Pearson Education, Asia, 2003
4. Power Electronics and Variable Frequency Drives by B.K.Bose Standard Pub, 2000.

Reference Books:

1. Thyristor DC Drives by P.C.Sen John Wiley & Sons, 1981.

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2. Power Electronic Control of AC Motors by JMD Murphy & FG Turnbull Pergamon Press,1988.
3. Power Semiconductor Controlled Drives by G.K. Dubey PH Int., 1989
4. Electric Drives-Concepts and Applications by V.Subrahmanyam, TMH, 1994.
5. Sensor less Vector and Direct Torque Control P. Vas Oxford Press, 1998.
6. Analysis of Thyristor Power Conditioned Motors by S.K.Pilley University Press, 1992.
7. http://www.nptel.iitm.ac.in/
8. www.ocw.mit.edu

Course Outcomes:

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

EEU821.E.1. Analyze and simulate basic models of dc and ac drives.
EEU821.E.2. Derive required characteristics from motor with the help of suitable controller.
EEU821.E.3. Justify the applications of BLDC, SRM and sensor-less drives.
EEU821.E.4. Understand the principles of vector controlled and direct torque controlled induction motor drives.
EEU821.E.5. Emphasize the measures of energy conservation in electrical drives.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU821E.1	2	2	0	0	3	0	0	0	0	0	0	0	2	0	0
EEU821E.2	2	0	1	0	1	0	0	0	0	0	0	0	1	0	0
EEU821E.3	2	0	1	1	0	2	0	0	0	0	0	2	1	2	0
EEU821E.4	2	2	0	1	2	0	0	0	0	0	0	1	1	0	0
EEU821E.5	0	0	0	0	1	2	2	1	0	0	0	1	2	2	0

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EEU822 PROJECT AND SEMINAR/ INDUSTRY INTERNSHIP PROJECT

Teaching Scheme : 03 P Total: 03 **Credit: 14**

Evaluation Scheme: 200 ICA + 200 ESE **Total Marks: 400**

Duration of ESE: 3 Hrs.

Course Objectives:

I. To develop skills in doing literature survey, technical presentation and report preparation
II. To Perceive the idea and decide the objectives of project from literature survey
III. To enable project identification and execution of preliminary works on project

1. Student shall select and deliver a topic for seminar which is **not covered in curriculum**
2. In general, a group of 3-6 students should be allowed to complete the project on Approved topic.
3. Preferably more than 25 % projects shall be Industry / Research based / oriented.
4. Exhaustive survey of literature based on a clear definition of the s cope and focus of the topic should be carried out by the students.
5. Students should finalize the topic for the project after literature survey in consultation with the Guide.
6. The **Synopsis/Abstract** on the selected topic should be submitted to the H.O.D. for approval.
7. On approval of the topic, students should initiate the topic based work.
8. Students should complete implementation of ideas given in synopsis, so that project work should be completed before end of semester.
9. Students shall submit the final project report in proper format as per guide lines given on the college website which shall include the work of both semesters.
10. For uniform and continuous evaluation, evaluation committee for each group s hall be formed by Program Head in which guide must be a member. Internal marks should be awarded by committee at the end of semester based on continuous evaluation.
11. Final examination of project shall include demonstration, presentation of complete work and oral examination based on the project work.

INDUSTRY INTERSHIP PROJECT

I. The aim of Industry Internship Project is to closely work with industry to apply theoretical knowledge in a real-world context providing real industrial project enabling learning focused on the application knowledge. This gives a student an

opportunity to make their first traces in the industrial reality and start building a personal network, an important prerequisite for a successful industry career.

II. The purpose of the INDUSTRY INTERSHIP PROJECT to solve real industrial problems by following established engineering methods, working in teams, and effectively communicating with various stakeholders.

III. The students can work in group decided by the department as per availability of Faculty. The individual students can also undertake the Industry Institute Project subject to availability of Industry Mentor/Guide. Students/Group selects the industry which is ready to provide INDUSTRY INTERSHIP PROJECT through oral/written communication. Once selected the student group has to visit the industry/stay as per need. The institute will not provide any assistance in Travel and Stay. The student/ Group need to submit acceptance letter from Industry regarding allowing the student/groups for INDUSTRY INTERSHIP PROJECT stating the Project name or research area.

IV. Each group has an Industry Project Guide and Institute Project Guide. The meeting with Project guide is once within week/two week at Institute. These meetings typically include assistance in finding solutions recent problems in the projects, technical support on applied software packages, and support with writing the final report. The project groups do multiple company visits where they meet the industrial contacts to formulate the problem, collect data and information, and gain necessary experiences from the industry.

V. Furthermore, INDUSTRY INTERSHIP PROJECT includes seminars aiming to give the students experience of communicating to a larger audience, working in teams, etc. The Project monitoring will be done by Institute Guide to know whether learning objective is achieved or not.

VI. The INDUSTRY INTERSHIP PROJECT undergone individual student/ Group will have to submit following documents on the successful completion of Industry Institute Project

1. Authenticated attendance record from Industry internship project mentor/supervisor/Guide
2. Industry internship project signed by Industry Mentor/Guide
3. Industry internship project Completion Letter by Industry Mentor/ Guide
4. Project evaluation report signed by Industry Mentor/ Guide

Note:

ICA: The Internal Continuous Assessment shall be based on the active participation of the students in the Project work and knowledge/skill acquired. Oral examination shall b e conducted on the Project report, by the panel of examiners consisting of Project Guide, Course Coordinator and Expert appointed by Program Head.

ESE: The End Semester Examination for Project shall consist of Demonstration if any, presentation and oral examinations based on the project report.

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Course Outcomes:

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

EEU822.1. Perceive the idea and decide the objectives of project from literature survey
EEU822.2. Integrate information from multiple sources.
EEU822.3. Identify, analyze, and solve problems creatively through sustained critical investigation.
EEU822.4. Implement the idea with effective leadership in prescribed schedule
EEU822.5. Prepare the effective technical document related to work carried out

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EEU822.1	3	1	3	0	0	0	0	0	3	0	2	0	3	2	1
EEU822.2	2	3	2	3	0	0	0	0	2	0	3	0	1	3	0
EEU822.3	2	2	3	2	0	0	0	0	2	0	2	0	2	2	2
EEU822.4	2	2	3	2	0	0	0	0	2	0	2	0	2	3	3
EEU822.5	2	2	3	0	0	0	0	0	2	0	3	0	1	2	3

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Annexure –C

Equivalence Scheme -I

(VI & VIII Sem)

S. N.	Course in new scheme (164)			Equivalent course in old Scheme (184)		
	Course Code	Course name	No. of Credits	Course Code	Course name	No. of Credits
1	EEU721	Electrical Drives and Control	**3**	EEU802	Electrical Drives and control	**3**
2	**EEU722A**	A) EHV AC Transmission	**3**	EEU804B	High voltage Transmission	**3**
3	EEU722B	B) High Voltage Engineering	**3**	EEU803B	HV High Voltage Engineering	**3**
4	EEU722C	C) AI and Machine Learning	**3**		No Equivalence	--
5	EEU722D	D) Data Structures	**3**			
6	EEU722E	E) Energy Storage System	**3**			
7	EEU723A	A) Power System Modelling	**3**		No Equivalence	--
8	EEU723B	B) Smart Grid	**3**			
9	EEU723C	C) Advanced Microprocessors	**3**	EEU703B	Advanced Microprocessors	**3**
10	EEU723D	D) Algorithms	**3**		No Equivalence	--
11	EEU723E	E) Power System Transients	**3**			
12	EEU733A	Fundamental of Electrical Drives	**3**		No Equivalence	--
13	EEU733B	Electrical Estimating and Costing	**3**		No Equivalence	--
14	EEU725A	A) HVDC and FACTS	**3**	EEU804A	HVDC and FACTS	**3**
15	EEU725B	B) Power Quality Issues and Mitigation	**3**	EEU804C	Power Quality & Deregulation	**3**
16	EEU725C	C) Digital Control System	**3**		No Equivalence	--
17	EEU725D	D)Computer Network	**3**		No Equivalence	--
18	EEU725E	E) Power System planning and Design	**3**		No Equivalence	--
19	EEU727	Energy Management	**3**		No Equivalence	--
20	EEU725	Electrical Drives and Control Lab	**2**	EEU806	Electrical Drives and Control Lab	**2**
21	EEU821A	A) Power System Dynamics and Stability	**3**	EEU801	Power System Stability	**3**
22	EEU821B	B)Wind and Solar Systems	**3**		No Equivalence	--
23	EEU821C	C)Electrical and Hybrid Vehicles	**3**		No Equivalence	--
24	EEU821D	D) Cyber Security	**3**		No Equivalence	--
25	EEU821E	Advanced Drives	**3**		No Equivalence	--
26	EEU822	C. Project and Seminar **OR** D. Industry Internship Project	**26**		No Equivalence	--

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Department of Electrical Engineering

Equivalence Scheme

Programme Name:- Electrical Engineering

Course in old scheme			Course in new scheme		
Course code	Course name	No of credits	Course code	Course name	No of credits
EEU201	Basic Electrical Engineering	02	EEU121	Basic Electrical Engineering	03
EEU202	Basic Electrical Engineering Lab.	01	EEU122	Basic Electrical Engineering Lab.	01

Equivalence-I
(III & IV Sem)

S. N.	Course in old Scheme (184)			Equivalent course in new scheme (155)		
	Course Code	Course name	No. of Credits	Course Code	Course name	No. of Credits
1	SHU303	Engineering Mathematics - III	3	SHU321C	Transform and Statistical methods	4
2	ETU311	Electronic Devices and Circuits	3	EEU326	Analog Electronic Circuits	3
3	EEU301	Signals & Systems	4	EEU422	Signals & Systems	4
4	EEU302	Network Analysis	4	EEU322	Electrical Circuit Analysis	4
5	EEU303	Electrical Measurement and Instrumentation	3		-----	
6	ETU312	Electronic Devices and Circuits Lab	2	EEU327	Analog Electronic Lab	1
7	EEU304	Signals & Systems Lab	1		----	
8	EEU305	Network Analysis Lab	1	EEU325	Electrical Circuit Analysis Lab	1
9	EEU306	Electrical Measurement and Instrumentation Lab	1	EEU424	Electrical Measurement and Instrumentation Lab	3
10	SHU305	General Proficiency – II	1		----	
11	ETU331C	Analog Electronic Circuits	3	EEU326	Analog Electronic Circuits	3
12	EEU332C	Analog Electronic Circuits	3	EEU326	Analog Electronic Circuits	3
13	SHU401	Engineering Mathematics - IV	3		----	
14	EEU401	Pulse & Digital Circuits	4	EEU426	Digital Electronics	3
15	EEU402	Electrical Machines – I	3	EEU321	Transformers and DC Machines	3
16	EEU403	Energy Resources & Generation	3	EEU323	Energy Resources & Generation	3
17	EEU404	Electromagnetic Engineering	4	EEU423	Electromagnetic Fields	4
18	SHU402	Engineering Mathematics Lab	2	----		

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19	EEU405	Pulse & Digital Circuits Lab	1	EEU 427	Digital Electronics Lab	1
20	EEU406	Electrical Machines - I Lab	1	EEU324	Electrical Machines Lab I	1
21	EEU407	Numerical Methods Lab	1		-----	
22	EEU408	Computational Lab – I	1		------	
23	ETU431C	Digital Electronics	3	EEU426	Digital Electronics	3
24	ETU 432C	Digital Electronics Lab	1	EEU 427	Digital Electronics Lab	1

Equivalence-II

S. N.	Course in new scheme (155)			Equivalent course in old Scheme (184)		
	Course Code	Course name	No. of Credits	Course Code	Course name	No. of Credits
1	SHU321C	Engineering Mathematics - III	**4**	----	----	----
2	EEU326	Analog Electronic Circuits	3	ETU311	Electronic Devices and Circuits	3
3	EEU326	Analog Electronic Circuits	3	ETU331C	Analog Electronic Circuits	**3**
4	EEU321	Transformers & DC Machines	**3**	EEU402	Electrical Machines - I	3
5	EEU322	Electrical Circuit Analysis	**4**	EEU302	Network Analysis	4
6	EEU323	Energy Resources & Generation	**3**	EEU 403	Energy Resources & Generation	**3**
7	EEU327	Analog Electronic Lab	1	ETU312	Electronic Devices and Circuits Lab	1
8	EEU327	Analog Electronic Lab	1	ETU322C	Analog Electronic Lab	**1**
9	EEU324	Electrical Machines Lab I	**1**	EEU406	Electrical Machines - I Lab	1
10	EEU325	Electrical Circuit Analysis Lab	**1**	EEU305	Network Analysis Lab	1
11	SHUMC	Environmental Sciences	**0**		Environmental Sciences	0
12	EEU426	Digital Electronics	**3**	EEU401	Pulse & Digital Circuits	4
13	EEU426	Digital Electronics	**3**	ETU 431C	Digital Electronics	**3**
14	EEU421	AC Machines	**3**	EEU502	Electrical Machines - II	3
15	EEU422	Signals & Systems	**4**	EEU301	Signals & Systems	4
16	EEU423	Electromagnetic Fields	**4**	EEU404	Electromagnetic Engineering	4
17	SHU423 C	Biology – I	**2**	---		
18	EEU424	Electrical Measurement and Instrumentation Lab	**3**	EEU306	Electrical Measurement and Instrumentation Lab	1
19	EEU 427	Digital Electronics Lab	1	EEU405	Pulse & Digital Circuits Lab	1
20	EEU 427	Digital Electronics Lab	1	ETU432C	Digital Electronics Lab	**1**
21	EEU425	Electrical Machines Lab II	**1**	EEU506	Electrical Machines - II Lab	1
22	SHUMC	NCC/NSS	**0**		NCC/NSS	0

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Equivalence Scheme -I
(V & VI Sem)

S. N.	Course in new scheme (164)			Equivalent course in old Scheme (184)		
	Course Code	Course name	No. of Credits	Course Code	Course name	No. of Credits
1	EEU521	Power Electronics	**3**	EEU601	Power Electronics	**3**
2	EEU522	Power Systems – Apparatus and Modelling	**4**	EEU502	Power System Analysis- I	**3**
3	EEU523	Control System	**3**	EEU503	Control System - I	**3**
4	EEU524	Microprocessor and Microcontrollers	**3**	EEU504	Introduction to Microprocessor and Microcontrollers	**3**
5	EEU525	Industrial Organization & Management	**3**	EEU505	Industrial Organization & Management	**3**
6	EEU526A	Electrical Machine Design	**3**	EEU604	Electrical Machine Design	**3**
7	EEU526B	Industrial Electrical Systems	**3**	No equivalence		
8	EEU526C	Digital Signal Processing	**3**			
9	EEU526D	Computer organisation	**3**			
10	EEU526E	Embedded Systems	**3**			
11	EEU527	Power Electronics Lab	**1**	EEU606	Power Electronics Lab	**1**
12	EEU528	Power Systems – Apparatus and Modelling Lab	**1**	EEU507	Power System Analysis - I Lab	**1**
13	EEU529	Control Systems Lab	**1**	EEU508	Control System - I Lab	**1**
14	EEU530	Microprocessor and Microcontrollers Lab	**1**	EEU509	Introduction to Microprocessor and Microcontrollers Lab	**1**
15	EEU621	Power Systems –Operation and Control	**3**	EEU602	Power System Analysis - II	**3**
16	EEU622	Control System Design	**4**		No equivalence	
17	EEU623	Operation Research Techniques	**4**	EEU605	Operation Research Techniques	**3**
18	EEU624A	Power system Protection	3	EEU701	Switch Gear and Protection	**3**
19	EEU624B	Energy Conservation in Electrical Utilities	**3**	No equivalence		
20	EEU624C	Object Oriented Programming	**3**			
21	EEU624D	Internet of Things	**3**			
22	EEU633A	Electromechanical Energy Conversion	**3**	EEU704A	Electromechanical Energy Conversion	**3**
23	EEU633B	Energy Efficiency in Electrical Utilities	**3**	EEU704C	Energy Efficiency in Electrical Utilities	**3**
24	ETU631	Electronics Design Lab	**3**	No equivalence		
25	EEU626	Power Systems –Operation and Control Lab	**1**	EEU607	Power System Analysis - II Lab	**1**
26	EEU627	Control System Design Lab	**1**	No equivalence		
27	EEU628	Minor Project	**2**	EEU610	Minor Project	**2**

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Equivalence Scheme -II

S. N.	Course in old Scheme (184)			Equivalent Course in new scheme (164)		
	Course Code	Course name	No. of Credits	Course Code	Course name	No. of Credits
1	EEU501	Electrical Machines II	**3**	EEU421	AC Machines	3
2	EEU502	Power System Analysis- I	**3**	EEU522	Power Systems – Apparatus and Modelling	**4**
3	EEU503	Control System - I	**3**	EEU523	Control System	**3**
4	EEU504	Introduction to Microprocessor and Microcontrollers	**3**	EEU524	Microprocessor and Microcontrollers	**3**
5	EEU505	Industrial Organization & Management	**3**	EEU525	Industrial Organization & Management	**3**
6	EEU506	Electrical Machines II Lab	**1**	EEU425	Electrical Machines Lab II	**1**
7	EEU507	Power System Analysis - I Lab	**1**	EEU528	Power Systems – Apparatus and Modelling Lab	**1**
8	EEU508	Control System - I Lab	**1**	EEU529	Control Systems Lab	**1**
9	EEU509	Introduction to Microprocessor and Microcontrollers Lab	**1**	EEU530	Microprocessor and Microcontrollers Lab	**1**
10	EEU510	Computational Lab-II	**2**	No equivalence		
11	EEU511	Self study I	**2**	No equivalence		
12	EEU601	Power Electronics	**3**	EEU521	Power Electronics	**3**
13	EEU602	Power System Analysis - II	**3**	EEU621	Power Systems –Operation and Control	**3**
14	EEU603	Control System -II	**3**		No equivalence	
15	EEU604	Electrical Machine Design	**3**	EEU526A	Electrical Machine Design	**3**
16	EEU605	Operation Research Techniques	**3**	EEU623	Operation Research Techniques	**4**
17	EEU606	Power Electronics Lab	**1**	EEU527	Power Electronics Lab	**1**
18	EEU607	Power System Analysis - II Lab	**1**	EEU626	Power Systems –Operation and Control Lab	**1**
19	EEU608	Control System –II Lab			No equivalence	
20	EEU609	Electrical Machine Design Lab		No equivalence		
21	EEU610	Minor Project	**2**	EEU628	Minor Project	**2**
22	EEU611	Self Study-II		No equivalence		
23	EEU612	Industrial Lecturer -I	**-**	No equivalence		

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Equivalence Scheme
(VII & VIII Sem)

S. N.	Course in old Scheme (184)			Equivalent Course in new scheme (164)		
	Course Code	Course name	No. of Credits	Course Code	Course name	No. of Credits
1	EEU701	Switch Gear and Protection	3	EEU624A	Power system Protection	3
2	EEU702	Linear & Digital Integrated Circuits	3		No Equivalence	--
3	EEU703 A	A) Digital Signal Processing	3		No Equivalence	3
4	EEU703 B	B) Advanced Microprocessor	3	EEU723C	C) Advanced Microprocessors	3
5	EEU703 C	C) Computer Methods in Power System Analysis	3		No Equivalence	--
6	EEU703 D	D) Power System Operation and Control	1	EEU621	Power Systems –Operation and Control	3
7	EEU704 A	A) Electromechanical Energy Conversion	1		No Equivalence	--
8	EEU704 B	B) Robotics and Automation	1		No Equivalence	--
9	EEU705	Switch Gear and Protection Lab	1		No Equivalence	--
10	EEU706	Linear & Digital Integrated Circuits Lab	1	No Equivalence		--
11	EEU707 A	A) Digital Signal Processing lab	1	No Equivalence		--
12	EEU707 B	B) Advanced Microprocessor lab	1		No Equivalence	--
13	EEU707 C	C) Computer Methods in Power System Analysis lab	1		No Equivalence	--
14	EEU707 D	D) Power System Operation and Control lab	1		No Equivalence	--
15	EEU708	Project Phase - I	2		No Equivalence	--
16	EEU709	Seminar	2		No Equivalence	--
17	EEU710	Industrial Training /Visit	1		No Equivalence	--
18	EEU711	Industrial Lecture - II*	1		No Equivalence	--
19	EEU712	Self Study - III	2		No Equivalence	--
20	EEU801	Power Systems Stability	3	EEU821A	D) Power System Dynamics and Stability	3
21	EEU802	Electrical Drives and Control	3	EEU721	Electrical Drives and Control	3
22	EEU803 A	A) Multirate DSP and Wavelet	3	No Equivalence		
23	EEU803 B	B) High Voltage Engineering	3	EEU722B	High Voltage Engineering	3
24	EEU803 C	C) Network Synthesis	3	No Equivalence		--

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25	EEU803 D	D) Artificial Neural Network	**3**	No Equivalence		--
26	EEU804A	A) HVDC and FACTS	**3**	EEU725A	HVDC and FACTS	**3**
27	EEU804B	B) High Voltage Transmission	**3**	**EEU722A**	EHV AC Transmission	**3**
28	EEU804 C	C) Power Quality & Deregulation	**3**	EEU725B	Power Quality Issues and Mitigation	**3**
29	EEU804D	D) Statistical Signal Processing	**3**	No Equivalence		--
30	EEU805	Power Systems Dynamics Lab	**1**	No Equivalence		--
31	EEU806	Electrical Drives and Control Lab	**1**	No Equivalence		--
32	EEU807A	A) Multirate DSP and Wavelet lab	**1**	No Equivalence		--
33	EEU807B	B) High Voltage Engineering lab	**1**	No Equivalence		--
34	EEU807 C	C) Network Synthesis lab	**1**	No Equivalence		--
35	EEU807D	D) Artificial Neural Network lab	1	No Equivalence		--
36	EEU808	Project Phase - II	6	No Equivalence		--
37	EEU809	Self study - IV	2	No Equivalence		--

Member Secretary
(Dr. R.B. Sharma)

Chairman, BoS
(Dr. P.P. Bedekar)

Principal
(Dr. A.M. Mahalle)