FACULTY OF ENGINEERING

DEGREE OF BACHELOR OF ENGINEERING IN

ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(PART TIME PROGRAMME)

CURRICULUM AND SYLLABI

(2021 – 2022)

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

KARPAGAM ACADEMY OF HIGHER EDUCATION

Faculty of Engineering

Department of Electrical and Electronics Engineering

(Deemed University Established Under Section 3 of UGC Act 1856) Pollachi Main Road, Eachanari Post, Coimbatore- 641 021, India.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
FACULTY OF ENGINEERING
UG PROGRAM (CBCS) – B.E –EEE (PART TIME)
(2021–2022 Batch and onwards)

Course code	Name of the course	Category	Objectives and out comes		Instruction hours / week			Credit(s)	Maximum Marks			Page No
			PEOs	POs	L	T	P		CIA	ESE	Total	
									40	60	100	
	SEMESTER - I											
21PBEEE101	Engineering Mathematics-I	BSC	I	a,b,e,i	3	0	0	3	40	60	100	8
21PBEEE102	Electrical Machines -I	PCC	I,II	a,b,d,i	3	0	0	3	40	60	100	10
21PBEEE103	Electronic Devices and Circuits	PCC	I,II	a,b,d,f	3	0	0	3	40	60	100	12
21PBEEE104	Computer Fundamentals and C Programming	ESC	I.III	a,e,h,i	3	0	0	3	40	60	100	14
21PBEEE111	Computer Practices &Programming Laboratory	ESC	I.III	a,e,h,i.j	0	0	3	2	40	60	100	16
Semester Total					12	0	3	14	200	300	500	
	SEMESTER – II											
21PBEEE201	Engineering Mathematics -II	BSC	I	a,b,e,i	3	0	0	3	40	60	100	17
21PBEEE202	Electrical Machines II	PCC	I,II	a,b,d,i	3	0	0	3	40	60	100	19
21PBEEE203	Measurements and Instrumentation	PCC	I.III	a,b,d,f	3	0	0	3	40	60	100	21
21PBEEE204	Environmental Sciences	HSMC	II,III	c,f,	3	0	0	3	40	60	100	23
21PBEEE211	DC and AC Machines Laboratory	LC	.III	a,b,d,i	0	0	3	2	40	60	100	25
Semester Total					12	0	3	14	200	300	500	

Course code	Name of the course	Category	Objectives and out comes		Instruction hours / week			Credit(s)	Maximum Marks			Page No
			PEOs	POs	L	T	P		CIA	ESE	Total	
									40	60	100	
	SEMESTER - III											
21PBEEE301	Power Electronics	PCC	I	a,b,e,i	3	0	0	3	40	60	100	27
21PBEEE302	Analysis of Electric Circuits	PCC	I,II	a,b,d,i	3	0	0	3	40	60	100	29
21PBEEE303	Control System Engineering	PCC	I,II	a,b,d,f	3	0	0	3	40	60	100	31
21PBEEE304	Renewable Energy Sources	PCC	I.III	a,e,h,i	3	0	0	3	40	60	100	33
21PBEEE311	Control System Engineering Laboratory	LC	I.III	a,e,h,i.j	0	0	3	2	40	60	100	35
Semester Total					12	0	3	14	200	300	500	
	SEMESTER – IV											
21PBEEE401	Solid State Drives	PCC	I	a,b,e,i	3	0	0	3	40	60	100	36
21PBEEE402	Transmission and Distribution Systems	PCC	I,II	a,b,d,i	3	0	0	3	40	60	100	38
21PBEEE403	Linear Integrated Circuits	PCC	I.III	a,b,d,f	3	0	0	3	40	60	100	40
21PBEEE404	Power Plant Engineering	PCC	II,III	c,f,	3	0	0	3	40	60	100	42
21PBEEE411	Power Electronics and Drives Laboratory	LC	.III	a,b,d,i	0	0	3	2	40	60	100	44
Semester Total					12	0	3	14	200	300	500	

Course code	Name of the course	Category	Objectives and out comes		Instruction hours / week			Credit(s)	Maximum Marks			Page No
			PEOs	POs	L	T	P		CIA	ESE	Total	
									40	60	100	
SEMESTER - V												
21PBEEE501	High Voltage Engineering	PCC	I	a,b,e,i	3	0	0	3	40	60	100	46
21PBEEE502	Power System Analysis	PCC	I,II	a,b,d,i	3	0	0	3	40	60	100	48
21PBEEE5--	Professional Elective I	PEC	I,II	a,b,d,f	3	0	0	3	40	60	100	50
21PBEEE5--	Professional Elective II	PEC	I.III	a,e,h,i	3	0	0	3	40	60	100	
21PBEEE511	Electronics Laboratory	LC	I.III	a,e,h,i.j	0	0	3	2	40	60	100	
21PBEEE591	Mini Project	Mini Proj			0	0	3	1	100	0	100	52
Semester Total					12	0	6	15	300	300	600	
SEMESTER – VI												
21PBEEE601	Power System Operation and Control	PCC	I	a,b,e,i	3	0	0	3	40	60	100	53
21PBEEE602	Engineering Economics and Financial Management	HSMC	I,II	a,b,e,d,i	3	0	0	3	40	60	100	55
21PBEEE6E__	Professional Elective III	PEC	I.III	a,b,d,f	3	0	0	3	40	60	100	
21PBEEE6E__	Professional Elective IV	PEC	II,III	a,c,f,	3	0	0	3	40	60	100	
21PBEEE611	Power System Simulation Laboratory	LC	.III	a,b,d,i	0	0	3	2	40	60	100	57
21PBEEE691	Project work and Viva-Voce Phase 1	Proj			0	0	3	3	40	60	100	58
Semester Total					12	0	6	17	240	360	600	

Course code	Name of the course	Category	Objectives and out comes		Instruction hours / week			Credit(s)	Maximum Marks			Page No
			PEOs	POs	L	T	P		CIA	ESE	Total	
									40	**60**	**100**	
	SEMESTER - VII											
21PBEEE701	Total Quality Management	HSMC	I	a,b,e,i	3	0	0	3	40	60	100	59
21PBEEE7E_	Professional Elective V	PEC	I,II	a,b,d,i	3	0	0	3	40	60	100	
21PBEEE7E_	Professional Elective VI	PEC	I,II	a,b,d,f	3	0	0	3	40	60	100	
21PBEEE791	Project work and Viva-Voce Phase 2	Proj	I.III	a,e,h,i	0	0	9	6	120	180	300	61
Semester Total					9	0	9	15	240	360	600	
Program Total					**81**	**0**	**33**	**103**	**1580**	**2220**	**3800**	

LIST OF ELECTIVES

PROFESSIONAL ELECTIVE –I & II												
Course code	**Name of the course**	**Category**	**Objectives and out comes**		**Instruction hours / week**			**Credit(s)**	**Maximum Marks**			**Page No**
			PEOs	**POs**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
21PBEEE5E01	Data Structures and Algorithms	PEC	1	b,d,i,j	3	0	0	3	40	60	100	62
21PBEEE5E02	Computer Networks	PEC	1	a,b,c,k	3	0	0	3	40	60	100	64
21PBEEE5E03	Network Analysis and Synthesis	PEC	1	a,b,d	3	0	0	3	40	60	100	66
21PBEEE5E04	Special Electrical Machines	PEC	2	a,d,f,h	3	0	0	3	40	60	100	68
21PBEEE5E05	Energy Management, Utilization and Auditing	PEC	2	a,c,j,k	3	0	0	3	40	60	100	70
21PBEEE5E06	Distributed Generation	PEC	2	a,b,d	3	0	0	3	40	60	100	72
21PBEEE5E07	Industrial Automation	PEC	2	a,c,d,h	3	0	0	3	40	60	100	74
21PBEEE5E08	Consumer Electronics	PEC	2	b,d,h,i	3	0	0	3	40	60	100	76

PROFESSIONAL ELECTIVE – III & IV												
Course code	**Name of the course**	**Category**	**Objectives and out comes**		**Instruction hours / week**			**Credit(s)**	**Maximum Marks**			**Page No**
			PEOs	**POs**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
21PBEEE6E01	Design of Electrical Apparatus	PEC	1	b,d,h,i	3	0	0	3	40	60	100	78
21PBEEE6E02	Digital Logic Circuits	PEC	2	a,b,c,i	3	0	0	3	40	60	100	80
21PBEEE6E03	HVDC and EHVAC	PEC	1	a,b,d	3	0	0	3	40	60	100	81
21PBEEE6E04	Computer Architecture	PEC	2	a,b,d	3	0	0	3	40	60	100	83
21PBEEE6E05	Introduction to Neural Networks	PEC	2	a,c,d,h	3	0	0	3	40	60	100	85
21PBEEE6E06	Biomedical Instrumentation	PEC	2	b,d,h,i	3	0	0	3	40	60	100	87
21PBEEE6E07	Sensors and Transducers	PEC	2	a,c,d,i	3	0	0	3	40	60	100	89
21PBEEE6E08	Flexible AC Transmission Systems	PEC	1	a,c,d	3	0	0	3	40	60	100	91
21PBEEE6E09	Professional Ethics	PEC	2	a.b.d	3	0	0	3	40	60	100	93
21PBEEE6E10	Microprocessor and Microcontroller	PEC	1	g,j,k	3	0	0	3	40	60	100	95

PROFESSIONAL ELECTIVE –V & VI												
Course code	**Name of the course**	**Category**	**Objectives and out comes**		**Instruction hours / week**			**Credit(s)**	**Maximum Marks**			**Page No**
			PEOs	**POs**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
21PBEEE7E01	Fuzzy logic and its Applications	PEC	2	b,d,h,i	3	0	0	3	40	60	100	97
21PBEEE7E02	Digital Signal Processing	PEC	2	a,c,d,i	3	0	0	3	40	60	100	99
21PBEEE7E03	Power Quality	PEC	1	a,c,d	3	0	0	3	40	60	100	101
21PBEEE7E04	Power System Restructure	PEC	2	a.b.d	3	0	0	3	40	60	100	103
21PBEEE7E05	Modern Semiconductor Devices	PEC	1	b,d,h,i	3	0	0	3	40	60	100	105
21PBEEE7E06	Smart Grid	PEC	1	a,b,d	3	0	0	3	40	60	100	107
21PBEEE7E07	Electric Hybrid Vehicle	PEC	2	a,b,d	3	0	0	3	40	60	100	109
21PBEEE7E08	Power System Protection and Switchgear	PEC	1	a,b,c,k	3	0	0	3	40	60	100	111

L: Lecture Hour **T**: Tutorial Hour **CIA**: Continuous Internal Assessment

P: Practical Hour **C:No**. of Credits **ESE**: End Semester Examinations

PCC – Programme Core Course **PE** - Program Elective

HSMC-Humanities, Social Science and Management Course

Semester – I

21PBEEE101 ENGINEERING MATHEMATICS I 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To understand geometrical aspects of curvature and elegant application of differential calculus which are needed in Engineering applications.
- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model Engineering problems.
- To familiarize the student with functions of several variables which is the foundation for many branches of Engineering.
- To introduce sequence and series which is central to many applications in Engineering.
- To solve problems by applying Differential calculus and Transforms

Course Outcomes (COs)

Upon completion of this course the students will be able

1. To solve the rank, Eigen values and eigenvectors, diagonalization of a matrix, Symmetric matrices and the students will be able to use matrix algebra techniques for practical applications.
2. To equip the students to have basic knowledge and understanding in one field of materials, differential calculus
3. To solve simple standard examples using the ideas of differential equations.
4. To apply various techniques to solve Partial Differential Equations
5. To develop the tool of power series for learning advanced Engineering Mathematics.
6. To apply the knowledge acquired to solve various Engineering problems.

UNIT I MATRICES

Review of Matrix Algebra - Characteristic equation – Eigen values and Eigenvectors of a real matrix – Properties – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic forms – Reduction to canonical form through orthogonal reduction.

UNIT II DIFFERENTIAL CALCULUS

Overview of Derivatives - Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes- Evolutes as Envelope of normals.

UNIT III DIFFERENTIAL EQUATIONS

Introduction to Ordinary differential equations: Linear ordinary differential equations of second and higher order with constant coefficients. Introduction to Partial differential equations: Linear Partial differential equations of second and higher order with constant coefficients.

UNIT-IV ANALYTIC FUNCTIONS

Analytic functions - Necessary and Sufficient conditions for an analytic function (without proof) – Cauchy-Riemann equations – Harmonic - Properties of analytic functions – Construction of an analytic function - Conformal mapping: w = z+a, az, 1/z and bilinear transformation.

UNIT- V Z -TRANSFORM AND DIFFERENCE EQUATIONS

Z-transform - Elementary properties – Inverse Z – transform – Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

SUGGESTED READINGS

1. Hemamalini. P.T, (2014), Engineering Mathematics. McGraw Hill Education (India) Private Limited, New Delhi, India
2. Sundaram, V. Lakhminarayan,K.A. &Balasubramanian,R. (2006), Engineering Mathematics
   for first year, Vikas Publishing Home , New Delhi, India
3. Grewel . B. S (2014) , Higher Engineering Mathematics , Khanna Publications, New Delhi
4. ShahnazBathul(2009) , Text book of Engineering Mathematics(Special Functions and Complex Variables), PHI Publications, New Delhi.

Semester – I

21PBEEE102 **ELECTRICAL MACHINES -I** **3H-3C**

Instruction Hours / week: L: 3 T:0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study the working principles of electrical machines using the concepts of electromechanical energy conversion principles .
- To derive expressions for generated voltage and torque developed in all Electrical Machines.
- To study the working principles of DC machines as Generator types,
- To study determination of their no- load/load characteristics, starting and methods of speed control of motors.
- To estimate the various losses taking place in D.C. Motor
- To study the different testing methods to arrive at their performance.

Course Outcomes (COs)

At the end of this course, students will demonstrate the ability to
1. Understand the concepts of magnetic fields
2. Understand the concepts of magnetic circuits.
3. Understand the operation of dc machines.
4. Analyse the differences in operation of different dc machine configurations.
5. Analyse the single phase transformers circuits.
6. Analyse the three phase transformers circuits.

UNIT I DC GENERATORS

Definitions – Basic laws and rules – Construction and operation - types - Emf equation - Commutation – Armature reaction – Parallel operation

UNIT II DC MOTORS

Definitions – Basic laws and rules - Operation - types – Back Emf equation - Torque equation -Starters – Speed control - Applications

UNIT III TESTING OF DC MACHINES

Losses and efficiency – Swinburne's, Hopkinson's and load tests – Retardation test – Electric braking.

UNIT IV SINGLE PHASE TRANSFORMER

Principle of operation – Types and construction–EMF equation-. Phasor diagram - Open Circuit and Short circuit test– Equivalent circuit – Load test – Regulation and efficiency - All day efficiency – Sumpner's test.

UNIT V THREE PHASE TRANSFORMER

Principle of operation – Types and construction -Three phase transformers connections – Scott connection – Parallel operation - Auto transformers- Inrush current phenomenon and its prevention – Off-load and On-load tap changing

SUGGESTED READINGS

1. Kothari D.P. and Nagrath I.J (2001) , Electric Machines, Tata McGraw Hill, Fourth Edition
2. Fitzgerald A.E., Kingsly C. and Kusko.A (2007), Electric Machinery , Tata McGraw Hill
3. SenS.K(2008), Electric Machinery, Khanna Publishers, New Delhi
4. TherajaB.L. and TherajaA.K (2007), A Text Book of Electrical Technology Vol. II, S.Chand & Co.Ltd., NewDelhi
5. BimbhraP.S(2009) , Electrical Machinery, KhannaPublishers, New Delhi

Semester – I

21PBEEE103 ELECTRONIC DEVICES AND CIRCUITS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To acquaint the students with construction, theory and characteristics of the P-N junction diode.
- To acquaint the students with construction, theory and characteristics of the Bipolar transistor
- To acquaint the students with construction, theory and characteristics of the Field Effect transistor, LED, LCD
- To acquaint the students with construction, theory and characteristics of the other photo electronic devices, Power control/regulator devices, Feedback amplifiers and oscillators.
- To study the MOSFET and its applications.
- To study amplifiers and operational amplifiers.

Course Outcomes (COs)

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

1. Illustrate the structure, operation and characteristics of PN junction diode and its applications
2. Understand the characteristics of transistors and its applications.
3. Obtain the MOSFET working.
4. Understand the functioning of OP-AMP and design OP-AMP based application circuits.
5. Understand the characteristics of special devices.
6. To impart knowledge on semiconductor devices, amplifiers, oscillators, pulse circuits.

UNIT I SEMICONDUCTOR DIODE

Theory of p-n junction–p-n junction as diode – p-n diode currents–Volt-amp characteristics–Diode resistance –Temperature effect of p-n junction–Transition and diffusion capacitance of p-n diode – zener diode –Diode switching times.

UNIT II TRANSISTOR

Junction transistor–Transistor construction CE, CB and CC configurations–Transistor switching times Voltage rating –Junction field effect transistor–pinch off voltage–output and transfer characteristics

UNIT III AMPLIFIER

CE, CC and Common base amplifiers –Differential amplifiers-Push-pull amplifiers - Negative feedback amplifiers-Voltage/current, series/shunt-Single and double tuned amplifier.

UNIT IV SPECIAL DEVICES

Construction and operation: 7-Segment Display, tunnel diode and laser diode, UJT, thermistors, piezoelectric devices, MOSFETS – FET as a variable resistor.

UNIT V OSCILLATORS AND PULSE CIRCUITS

Oscillators–Colpitts, Hartley, Phase shift, Wien Bridge and crystal oscillators .RC Diode clampers and clippers, Wave shaping circuits: Multi-vibrators types–Schmitt triggers–UJT based saw tooth oscillator

SUGGESTED READINGS

1. Jacob Millman & Christos.C.Halkias (2003), Electronic Devices& Circuits, Prentice Hallof India, NewDelhi.
2. David A. Bell (2003), Electronic Devices and Circuits, PrenticeHallof India,New Delhi.
3. Robert. L. Boylestad & Lo Nashelsky(2002), Electronic Devices & CircuitTheory, Pearson Education

Semester – I

21PBEEE104 COMPUTER FUNDAMENTALS AND C PROGRAMMING 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- Identify and understand the working of key components of a computer system.
- Identify and understand the various kinds of input-output devices and different types of storage media commonly associated with a computer.
- Understand, analyze and implement software development tools like algorithm, pseudo codes and programming structure.
- Study, analyze and understand logical structure of a computer program, and different construct to develop a program in 'C'language.
- To study the various representations of data, register transfer language for micro–operations and organization and design of a digital computer.
- To develop applications in C using strings, pointers, functions, structures

Course Outcomes (COs)

1. To have knowledge on computer hardwares and softwares.
2. To understand the various data representation techniques.
3. To make the students to get knowledge on software engineering methodologies
4. To know the correct and efficient ways of solving problems.
5. To learn to develop algorithm for simple problem solving.
6. To learn to program in C.

UNIT - I COMPUTER BASICS

Evolution of computers- Generations of computers- Classification of computers- Applications of computers- Computer Organization and Architecture- Computer Memory and Storage- Input Output Devices.

UNIT - II SOFTWARE, PROGRAMMING AND INTERNET

Algorithm- Flowchart- Pseudo code – Program control structures- Programming paradigms- Programming languages- Generations of Programming languages- Computer Software- Definition- Categories of Software - Internet- Evolution- Basic Internet terms- Internet-Applications

UNIT - III C FUNDAMENTALS

Introduction to C- Constants- Variables- Data types- Operators and Expressions- Managing Input and Output operations- Decision Making and Branching- Looping

UNIT - IV ARRAYS AND FUNCTIONS

Arrays- Character Arrays and Strings- User defined functions- Storage Classes

UNIT - V STRUCTURES AND FILES

Structures- Definition- Initialization- Array of Structures- Structures within structures- Structures and Functions- Unions- File Management in C

SUGGESTED READINGS

1. E.Balagurusamy(2017), Computer Fundamentals and C Programming, Mcgraw Higher Ed
2.ITL Education Solutions Ltd (2008), Introduction to Information Technology, Pearson Education. Delhi.
3. Rajaraman, V (2006), Fundamentals of Computers. IV Edition, Prentice Hall. New Delhi
4.Byron Gottfried (2002), Programming with C Second Edition, TMH, New Delhi

Semester – I

21PBEEE111 COMPUTER PRACTICES AND PROGRAMMING LABORATORY 3H-2C

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

Students undergoing this course are exposed to:

- To develop programs in C using basic constructs.
- To develop applications in C using file processing
- To provide an awareness to Computing and C Programming
- To learn to develop algorithm for simple problem solving
- To write programs to solve mathematical problems.
- To develop applications in C using strings, pointers, functions, structures

Course Outcomes (COs)

- Formulate the algorithms for simple problems
- Translate given algorithms to a working and correct program
- Correct syntax errors as reported by the compilers
- Identify and correct logical errors encountered at run time
- Write iterative as well as recursive programs
- Represent data in arrays, strings and structures and manipulate them through a program

LIST OFEXPERIMENTS

1. Working with word Processing, Spreadsheet and presentation software in Linux
2. Programming in Scratch:

Practicing fundamental concepts of programming like sequence, selection decision statements, working of loops and event driven programming

3. C Programming:

Practicing programs to get exposure to basic data types, algebraic expressions, Conditional statements, Input and Output Formatting, Decision Statements, Switch Case, Control structures, arrays, Strings and function

SUGGESTED READINGS

1. E.Balagurusamy(2017), Computer Fundamentals and C Programming, Mcgraw Higher Ed
2.ITL Education Solutions Ltd (2008), Introduction to Information Technology, Pearson Education. Delhi.
3. Rajaraman, V (2006), Fundamentals of Computers. IV Edition, Prentice Hall. New Delhi
4.Byron Gottfried (2002), Programming with C Second Edition, TMH, New Delhi

Semester – II

21PBEEE201 ENGINEERING MATHEMATICS II 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- The objective of this course is
- To impact analytical skills to the students in the areas of Multiple Integrals and applications of Vector Calculus.
- To understand the concepts and applications of Fourier Series.
- To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyze engineering problems.
- To understand the concepts and applications of Laplace transforms.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, to specify some difficult integration that appear in applications can be solved by complex integration in application areas such as fluid dynamics and flow of the electric current.

Course Outcomes (COs)

1. The students will learn:
2. To find the areas and volumes using Multiple Integrals
3. To improve their ability in Vector Calculus
4. To have better understanding in problems related to heat conduction, Communication systems, electro optics and electromagnetic theory.
5. To apply Laplace transforms for solving differential equations arising out of many physical situations in their engineering problems.
6. To understand relations between conformal mappings and quadratic differentials and how geometric structures are changing under conformal mappings.

UNIT-I MULTIPLE INTEGRALS

Double integration – Cartesian coordinates – Polar coordinates – Change of order of integration – Triple integration in Cartesian co-ordinates – Area as double integrals.

UNIT-II VECTOR CALCULUS

Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem, Gauss divergence theorem and Stoke's theorems (Statement Only)- Surfaces : hemisphere and rectangular parallelopipeds.

UNIT- III FOURIER SERIES

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier Series – Parseval's identify – Harmonic Analysis.

UNIT- IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

UNIT-V LAPLACE TRANSFORMS

Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Initial and final value theorems. Inverse Laplace transforms – Convolution theorem – Solution of Ordinary Differential Equations with constant coefficients using Laplace transforms – Transform of periodic functions.

SUGGESTED READINGS

1. Hemamalini. P.T(2014),Engineering Mathematics I & II, McGraw-Hill Education Pvt.Ltd, New Delhi
2. Grewal, B.S. (2014), Higher Engineering Mathematics, Khanna Publishers, Delhi
3. Kandasamy. P, Thilagavathy. K, Gunavathy. K.(2008), Engineering Mathematics., S Chand & Co. Ltd, New Delhi
4.Erwin Kreyszig (2011), Advanced Engineering Mathematics.,John Wiley & Sons. Singapore

Semester – II

21PBEEE202 ELECTRICAL MACHINES II 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To learn Construction and performance of salient and non–salient type synchronous generators.
- To get the knowledge of operation and performance of synchronous motor.
- To study and understand the concept of AC machine windings.
- To study and understand the concepts of rotating magnetic fields.
- To study the operation and performance of 3 Phase induction motors and its starting and speed control.
- To study the Construction, principle of operation and performance of single phase induction motors and few special machines

.

Course Outcomes (COs)

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

1. Understand the concept of AC machine windings.
2. Understand the concepts of rotating magnetic fields.
3. Understand the operation of ac machines.
4. Analyse performance characteristics Induction Machines.
5. To understand the different types of single phase induction motor based on its starting methods.
6. Understand the operation of synchronous motor and analyze the performance of motor under different loading and excitation conditions.

UNITI ALTERNATORS

Alternators-Types and constructional features- Emf equation-Armature reaction-Load characteristics – Phasor diagram- redetermination of regulation by EMF, MMF and ZPF methods.

UNIT II TWO REACTION THEORY

Basic ideas of two reaction theory-Direct and quadrature axis reactances and their determination- Phasor diagram and regulation of salient pole alternators - Parallel operation – Synchronizing torque-Expression for synchronizing power.

UNIT III SYNCHRONOUS MOTORS

Synchronous motors – Principle of operation-Synchronous machines on infinite bus bars - Phasor diagram-V and inverted V curves-Current and power circle diagrams- Hunting and its suppression-Starting methods– Synchronous condenser.

UNITIV INDUCTION MOTORS

Poly phase induction motors-Types and constructional features – Principle of operation-Torque - slip characteristics -Effect of rotor resistance - Equivalent circuit - Circle diagram - Starting and speed control of Induction motor-Introduction to Induction generator.

UNITV SINGLE PHASE INDUCTION MOTOR

Construction and Principle of operation of single phase induction motor- Double

revolving field theory–Methods of starting– types-Applications.

SUGGESTED READINGS

1.Kothari D. P. andNagrathI. J (2011), Electric Machines, Tata McGraw Hill, Fourth Edition

2.TherajaB.L andTherajaA. K (2009), A Textbook ofElectrical Technology, Vol.II, SChand &Co.Ltd., NewDelhi

3.Fitzgerald A. E.,KingslyC. andKusko A (2007), ElectricMachinery, Tata McGraw Hill

4.Sen. S. K (2008), Electric Machinery, KhannaPublishers,New Delhi,

Semester – II

21PBEEE203 MEASUREMENTSAND INSTRUMENTATION 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To provide adequate knowledge in electrical and electronic measurement techniques and instruments.
- To make the students to have a clear knowledge of the basic laws governing the operation of the instruments, relevant circuits and their working.
- Introduction to general instrument system, error, calibration etc.
- Emphasis is laid on analog and digital techniques used to measure voltage, current, energy and power, etc.
- To study storage, display devices and transducers.
- To understand the concept virtual instrumentation

Course Outcomes (COs)

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

1. Understand the basic knowledge of measurement systems towards measurements, including error analysis, interpretation, experimental uncertainty, calibration, etc.
2. Apply basic concepts of measurement systems with electrical signals, including signal conditioners (gain, attenuation), indicating and recording devices.
3.Understand the concept of analog and digital systems.
4.Understand the usage of Oscilloscope, digital CRO.
5.Analyze the usage of transducer and applications
6.understand the application of virtual instrumentation

UNIT I INTRODUCTION

Functional elements of an instrument – Units and standards of measurements – Static and dynamic characteristics – Sources of Errors in measurement – DC and AC bridges – Wheatstone, Kelvin's double, Maxwell, Anderson, Wien and Schering bridges– Measurement of high resistance – Standards and calibration.

UNIT II MEASURING INSTRUMENTS

Classification of instruments – working principle of potentiometers – Principle of operation and construction of PMMC, MI, type instruments – Principle types and working of analog and digital voltmeters, ammeters and multimeters – Determination of B–H curve and measurement of iron loss – Instrument transformers – CT and PT – Instruments for measurement of frequency and phase.

UNIT III MEASUREMENT OF POWER AND ENERGY

Dynamometer type wattmeter – Single and three phase wattmeters – Induction type

instruments – Single and three phase energy meters – calibration of energy meters – direct and phantom loading – Grounding techniques – Megger - Power factor meter- Principle of operation, construction and types of digital frequency meters, Digital Energy meters.

UNIT IV STORAGE, DISPLAY DEVICES AND TRANSDUCERS

Magnetic measurements – Magnetic disk and tape–recorders – Strip chart recorder – XY recorder. Digital plotters and printers – Cathode ray Oscilloscope– digital CRO and dot matrix display. Classification of transducers – Selection of transducers – Resistive – capacitive and inductive transducers – LVDT – Piezo-electric, optical and digital transducers.

UNIT V VIRTUAL INSTRUMENTATION

Concept of VIs and sub VI - Display types – Digital – Analog – Chart and Graphs. Loops- structures - Arrays – Clusters. Local and global variables – String and file I/O. Timers and dialog control.

SUGGESTED READINGS

1 Sawhney. A. K. (2004), A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Co., New Delhi.

2.Gupta, J. B(2003) , A Coursein Electronicand ElectricalMeasurements, S. K. Kataria and Sons, Delhi.

Semester – II

21PBEEE204 ENVIRONMENTAL SCIENCES 3H-3C

Instruction Hours / week: L: 3 T: 1 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To give a comprehensive insight into natural resources, ecosystem and biodiversity.
- To educate the ways and means of the environment
- To protect the environment from various types of pollution.
- To impart some fundamental knowledge on human welfare measures.
- Create the awareness about environmental problems among people.
- Motivate public to participate in environment protection and improvement.

Course Outcomes (COs)

Upon completion of the course the students will be able to

1. Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
6. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
7. Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES

Definition, Scope and Importance – Need for public awareness -Forest resources: Use and over-exploitation, deforestation- Water resources-Use and over-utilization of surface and ground water, floods, drought, conflicts over water- Land resources-Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources- Food resources-World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture- Energy resources-Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources- role of an individual in conservation of natural resources.

UNIT II ECOSYSTEM

Chemistry and Environment- Environmental segments, Composition and Structure of atmosphere- Concept of an ecosystem- Structure, components and function of an ecosystem Energy flow in the ecosystem – Food chain, Food web and Ecological pyramids, Structure and function of Terrestrial ecosystem (Forest, Desert and Grassland ecosystem) and Aquatic ecosystem (Fresh water and Marine ecosystem)

UNIT III BIODIVERSITY

Introduction to biodiversity, Definition- Genetic diversity, Species diversity and Ecosystem diversity, Biogeographical classification of India, Importance of biodiversity-Value of biodiversity - Hot Spots of biodiversity-Threats to biodiversity - Endangered and Endemic Species of India – Conservation of biodiversity- In-Situ and Ex-Situ conservation of biodiversity.

UNIT IV ENVIRONMENTAL POLLUTION

Definition – causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution and Thermal pollution. Solid waste management-causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution –Disaster management-earthquake, tsunami, cyclone and landslides

UNIT V SOCIAL ISSUES AND ENVIRONMENT

From Unsustainable to Sustainable development, Urban problems related to energy sources, Water conservation, Rain water harvesting and Watershed management, Resettlement and rehabilitation of people, its problems and concerns, Environmental ethics- Issues and possible solutions- Climate change- Green house effect and Global warming, Acid rain, Ozone layer depletion, Wasteland reclamation- Environment Protection Act- Human Rights- Value education, Role of Information Technology in Environment and Human health-Population growth, Variation of population among nations-Population explosion.

SUGGESTED READINGS

1. Dr. Ravikrishnan(2012), A, Environmental Science, Sri Krishna Hi tech Publishing CompanyPrivateLtd., Chennai

2. Anubhakaushik C.P. Kaushik (2010), Environmental Science and Engineering, New AgeInternational (P)Ltd., New Delhi.

3. William P.Cunningham(2008), Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi.

4. Tyler Miller G. Jr (2004), Environmental Science, Thomson &Thomson Publishers, New Delhi.,

Semester – II

21PBEEE211 DC AND AC MACHINES LABORATORY 3H-2C

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To experimentally verify the principle of operation, performance and characteristics of DC Motors.
- To experimentally verify the principle of operation, performance and characteristics of DC Generators and
- To experimentally verify the principle of operation, performance and characteristics of Transformers.
- To study the operation of DC motor starters,
- To study the different connections of Transformers.
- To expose the students to the operation of electrical machines and give them experimental skills.

Course Outcomes (Cos)

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

1. Analyze the characteristics of DC shunt generator DC compound generator and calculate critical resistance and critical speed
2. Examine load characteristics of DC shunt, series and compound motor and identify its maximum efficiency operating point
3. Estimate the efficiency of DC machines in different methods
4. Sketch the load characteristics of single phase transformer, separate the different losses and find the efficiency
5. Predetermine the equivalent circuit parameters of single phase transformer in two different methods and compare the results
6. Estimate the efficiency of transformer.

DC MACHINES

1. Open circuit characteristics and load test on separately excited DC generator.
2. Open circuit characteristics and load test on DC shunt generator.
3. Load test on DC series and DC shunt motor.
4. Swinburne's test and speed control on DC shunt motor.
5. OC and SC tests on single phase transformer.
6. Load test on single phase transformer.

AC MACHINES

7. V and Inverted V curves of Synchronous Motor
8. Load Test on three phase Induction Motor
9 Load Test on single phase Induction Motor

Suggested Readings

1.Kothari D. P. andNagrathI. J (2011), Electric Machines, Tata McGraw Hill,Fourth Edition
2.TherajaB.L andTherajaA. K (2009), A Textbook ofElectrical Technology, Vol.II, SChand &Co.Ltd., NewDelhi
3.Fitzgerald A. E.,KingslyC. andKusko A (2007), ElectricMachinery, Tata McGraw Hill
4.Sen. S. K (2008), Electric Machinery, KhannaPublishers,New Delhi,

Semester – III

21PBEEE301 **POWER ELECTRONICS** **3H-3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To introduce the application of electronic devices for conversion, control and conditioning of electric power.
- To get an overview of different types of power semi–conductor devices and their switching characteristics.
- To understand the operation, characteristics and performance parameters of controlled rectifiers and basic topologics of DC–DC switching regulators.
- To learn the different modulation techniques of pulse width modulated inverters and to understand the harmonic reduction methods.
- To know the practical application for power electronics converters in conditioning the power supply.
- Understand harmonic reduction methods.

Course Outcomes (COs)

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

1.Understand the differences between signal level .

2. Understand the differences between power level devices.

3.Analyse controlled rectifier circuits.

4.Analyse the operation of DC-DC choppers.

5.Analyse the operation of voltage source inverters.

6.Understand different modulation techniques.

UNIT I POWER SEMI CONDUCTOR DEVICES

Silicon Controlled Rectifier(SCR),TRIAC,DIAC - Structure, V-I Characteristics- Two Transistor Model, Structure and characteristics of Power Diode, Power BJT, MOSFET, IGBT, GTO, Comparisons of Power Semiconductor Devices-Firing circuits.

UNIT II PHASE CONTROLLED CONVERTERS

Operation and Analysis of Single Phase Half and Fully Controlled Converter using R, RL load- Three Phase Half and Fully Controlled Converter using R, RL load-Effects of Source Impedance, Dual converter (only Block diagram approach).

UNIT III CHOPPERS

Step-Down and Step-up Choppers-Control Strategies of Chopper- Multi Quadrant Operation of Chopper- Switched Mode Regulators: Buck, boost, Buck–Boost Regulator-Applications of DC Chopper.

UNIT IV DC-AC CONVERTER

Single phase half bridge and full bridge inverters - three phase bridge inverters (120 and 180 degree modes of operation)- Multilevel inverter (block diagram Approach only)- PWM techniques- single PWM, multiple PWM, Sinusoidal PWM, Current source inverter(CSI).

UNIT V AC-AC CONVERTER AND APPLICATIONS

Single phase cyclo converter, Single phase AC voltage controller- Applications- Uninterrupted Power Supply topologies (On line and Off line) – Flexible AC Transmission Systems –Unified Power Flow Controller– HVDC Transmission

SUGGESTED READINGS

1. Rashid Muhammad, H., "Power Electronics: Circuits, Devices and Applications", 2nd Ed. Prentice-Hall, 1998.
2. Mohan Ned, Undeland Tore, M. and Robbins William, P., "Power Electronics: Converter, Applications and Design", John Wiley & Sons, 1994.
3. Landev Cyrill, W., "Power Electronics", McGraw Hills, London, 1981.
4. Dewan, S.B. and Satrughan A., "Power Semiconductor Circuits", John Wiley & Sons, 1975.

Semester – III

21PBEEE302 **ANALYSIS OF ELECTRIC CIRCUITS** **3H-3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To gain knowledge on the principles and procedure for the Analysis of Circuits.
- To enable the students to understand the DC circuit analysis and network theorems.
- To learn the Sinusoidal steady state analysis.
- To understand transients and resonance in RLC circuits and coupled circuits
- Various electrical networks in presence of active and passive elements.
- To understand three phase circuits

Course Outcomes (COs)

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

1. Apply network theorems for the analysis of electrical circuits.
2. Obtain the solution of first and Second order system
3. Analyse the electrical circuits using Laplace Transforms.
4. Obtain the transient and steady-state response of electrical circuits.
5. Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
6. Analyse two port circuit behavior.

UNIT I BASIC CIRCUITS ANALYSIS

Ohm's Law – Kirchoffs laws – DC and AC Circuits – Resistors in series and parallel circuits – Mesh current and node voltage method of analysis for D.C and A.C. circuits.

UNIT II NETWORK REDUCTION AND NETWORK THEOREMS FOR DC

Network reduction: voltage and current division, source transformation – star delta conversion. Thevenin's and Norton & Theorem – Superposition Theorem – Maximum power transfer theorem
– Reciprocity Theorem.

UNIT III RESONANCE AND COUPLED CIRCUITS

Series and parallel resonance – their frequency response – Quality factor and Bandwidth - Self and mutual inductance – Coefficient of coupling – Tuned circuits – Single tuned circuits.

UNIT IV TRANSIENT RESPONSE FOR DC CIRCUITS

Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input.

UNIT V ANALYSING THREE PHASE CIRCUITS

Three phase balanced / unbalanced voltage sources – analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced – phasor diagram of voltages and currents – power factor measurements in three phase circuits

SUGGESTED READINGS

1. Sudakar A. and Shyam Mohan S.Palli Circuits and Networks, Tata McGraw Hill Book Co,2007
2. A.Chakrabarti, Circuit Theory – Analysis and Synthesis Dhanpat Rai & Co. New Delhi, Fifth Edition, 2006.
3. Arumugam and Prem Kumar, Electric Circuit Theory Khanna Publishers, New Delhi 2000
4. Joseph Edminister, Electric Circuits Schaum's outline series, Tata McGraw Hill Book Company, Third Edition,
2013

Semester – III

21PBEEE303 CONTROL SYSTEM ENGINEERING 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To understand the open loop and closed loop (feedback) systems
- To understand the use of transfer function models for analysis physical systems and introduce the control system components.
- To provide adequate knowledge in the time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- To introduce stability analysis and design of compensators.
- To introduce state variable representation of physical systems

Course Outcomes (COs)

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

- Demonstrate an understanding of the fundamentals of (feedback) control systems.
- Determine the time and frequency-domain responses of first and second-order systems to step and sinusoidal (and to some extent, ramp) inputs.
- Design the different types of compensators using frequency response plots to stabilize the control system
- Express and solve system equations in state-variable form (state variable models).
- Students can model any physical system in both time domain and frequency domain
- Students will be able to analyze the system and determine the stability property of system

UNIT-I CONTROL SYSTEM MODELLING

System concept, differential equations and transfer functions. Modeling of electric systems, translational and rotational mechanical systems, Simple electromechanical systems. Block diagram representation of systems – Block diagram reduction methods – Closed loop transfer function, determination of signal flow graph. Mason's gain formula – Examples.

UNIT-II TIME DOMAIN ANALYSIS

Test signals – time response of first order and second order systems – time domain specifications – types and order of systems – generalized error co-efficient – steady state errors – concepts of stability – Routh-Hurwitz stability – root locus.

UNIT-III FREQUENCY DOMAIN ANALYSIS

Introduction – correlation between time and frequency response – stability analysis using Bode plots, Polar plots, Nichols chart and Nyquist stability criterion – Gain margin – phase margin.

UNIT-IV COMPENSATORS

Realization of basic compensators – cascade compensation in time domain and frequency domain and feedback compensation – design of lag, lead, lag-lead compensator using Bode plot. Introduction to P, PI and PID controllers.

UNIT-V CONTROL SYSTEM COMPONENTS AND APPLICATION OF CONTROL SYSTEMS

Stepper motors – AC servo motor – DC servo motor – Synchros – sensors and encoders –DC tacho generator – AC tacho generator – Hydraulic controller – Pneumatic controller –Typical application of control system in industry.

SUGGESTED READINGS

1. Jacob Millman & Christos.C.Halkias (2003), Electronic Devices& Circuits, Prentice Hallof India, NewDelhi.
2. David A. Bell (2003), Electronic Devices and Circuits, PrenticeHallof India,New Delhi.
3. Robert.L. Boylestad & Lo Nashelsky(2002), Electronic Devices & CircuitTheory, Pearson Education

Semester – III

21PBEEE304 **RENEWABLE ENERGY SOURCES** **3H-3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To gain the knowledge about environmental aspects of energy utilization.
- To understand the basic principles of wind energy conversion, solar cells, photovoltaic conversion.
- To understand the basic principles fuel cell, Geo thermal power plants.
- To gain the knowledge about hydro energy.
- To understand the concept Wind Energy.
- To understand the concept hydro Energy.

Course Outcomes (COs)

At the end of the course student understands about all types of energy sources and utilization.

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

- Analyze the Energy Scenario in india.
- Understand the concept of Solar Energy
- Understand the concept of Wind Energy
- Understand the concept of Hydro Energy
- Analyze the different energy sources.
- At the end of the course student understands about all types of energy sources and utilization.

UNIT I INTRODUCTION

Energy scenario - Different types of Renewable Energy Sources - Environmental aspects of energy utilization - Energy Conservation and Energy Efficiency - Needs and Advantages, Energy Conservation Act 2003.

UNIT II SOLAR ENERGY

Introduction to solar energy: solar radiation, availability, measurement and estimation– Solar thermal conversion devices and storage – solar cells and photovoltaic conversion –PV systems – MPPT. Applications of PV Systems – solar energy collectors and storage.

UNIT III WIND ENERGY

Introduction – Basic principles of wind energy conversion- components of wind energy conversion system - site selection consideration – basic–Types of wind machines. Schemes for electric generation – generator control, load control, energy storage – applications of wind energy – Inter connected systems.

UNIT IV HYDRO ENERGY

Hydropower, classification of hydro power, Turbine selection, Ocean energy resources, ocean energy routes. Principles of ocean thermal energy conversion systems, ocean thermal power plants. Principles of ocean wave energy conversion and tidal energy conversion.

UNIT V OTHER SOURCES

Bio energy and types –Fuel cell, Geo-thermal power plants; Magneto-hydro-dynamic (MHD) energy conversion.

SUGGESTED READINGS

1. Rai.G.D, Non-conventional sources of energy Khanna publishers, 2011
2. Khan.B.H, Non-Conventional Energy Resources , The McGraw Hills, Second edition, 2012
3. John W Twidell and Anthony D Weir , Renewable Energy Resources , Taylor and Francis – 3rd edition , 2015

Semester –III

21PBEEE311 CONTROL SYSTEM ENGINEERING LABORATORY 3H-2C

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To provide a platform for understanding the basic concepts of linear control theory and its application to practical systems.
- To understand physical system in both time domain and frequency domain
- To analyze the system and determine the stability property of system
- To determine the controller for any system
- To understand the transfer function of DC motor, DC generator.
- To understand speed control of DC motor

Course Outcomes (COs)

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

- Determine the transfer function of DC Shunt Motor.
- Ability to find the frequency response of different compensators
- Ability to find the step response of P Controller.
- Ability to find the step response of PI & PID Controller.
- Ability to identify the type of damping from the given Characteristic equation.
- Evaluate the speed control of Dc motor.

LIST OF EXPERIMENTS

1. Transfer function of separately Excited DC generator.
2. Transfer function of armature controlled DC shunt motor.
3. Transfer function of field controlled DC shunt motor.
4. Transfer function of AC servomotor.
5. Step response of P, PI, and PID controllers.
6. Identification of type of damping from the given characteristic equation of second order system.
7. Frequency response of Lead compensator network.
8. Frequency response of Lag compensator network.
9. DC Motor speed control.

SUGGESTED READINGS

1. Jacob Millman & Christos.C.Halkias (2003), Electronic Devices& Circuits, Prentice Hallof India, NewDelhi.
2. David A. Bell (2003), Electronic Devices and Circuits, PrenticeHallof India,New Delhi.
3. Robert.L. Boylestad & Lo Nashelsky(2002), Electronic Devices & CircuitTheory, Pearson Education

Semester – IV

21PBEEE401 **SOLID STATE DRIVES** **3H-3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To study and understand the operation of electric drives controlled from a power electronic converter and to introduce the design concepts of controllers.
- To understand the stable steady–state operation and transient dynamics of a motor–load system.
- To study and analyze the operation of the converter/chopper fed dc drive and to solve simple problems.
- To study and understand the operation of both classical and modern induction motor drives.
- To understand the differences between synchronous motor drive and induction motor drive and to learn the basics of permanent magnet synchronous motor drives.
- To analyze and design the current and speed controllers for a closed loop solid–state dc motor drives.

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Course Outcomes (COs)

1. Understand the characteristics of dc motors and induction motors.
2. Understand the principles of speed-control of dc motors and induction motors.
3. Understand the power electronic converters used for dc motor and induction motor speed control.
4. Acquire detailed knowledge of DC Shunt and Series motor operation using Generalized machine theory
5. Acquire knowledge on how DC Drives may pollute the power supply and how to mitigate such pollution
6. Acquire detailed knowledge on AC-DC Converters and DC-DC Converters and their modeling for steady-state and transient

UNIT I DRIVE CHARACTERISTICS

Concept of Electric Drives –parts of electrical Drives – Dynamics of electric drive – torque equation – Selection of power rating of motor-Four quadrant operation of electric drives– Loads with rotational and translational motion – Steady state stability-components of load torques- Modes of operation and Characteristics.

UNIT II CONVERTER AND CHOPPER FED DC MOTOR DRIVES

Steady state analysis of the single and three phase converter fed separately excited DC motor drive – continuous and discontinuous conduction -Chopper controlled DC drives - Time ratio control and current limit control - Single, two and four quadrant operations.

UNIT III INDUCTION MOTOR DRIVES

Three phase induction motor drives-AC Voltage controlled drives- variable frequency control –V/f control -Slip Power recovery schemes- rotor frequency control -VSI fed induction motor drive and CSI fed induction motor drive- Basic of vector control.

UNIT IV SYNCHROUNOUS MOTOR DRIVES

V/f control and self control of synchronous motor: Margin angle control and power factor control - permanent magnet synchronous motor –Sinusoidal and Trapezoidal types, closed loop control of synchronous motor, Basics of Traction drives.

UNIT V CONTTROLLER FOR DRIVES

Transfer function for DC motor / load and converter – closed loop control with current and speed feedback, design of controllers; current controller and speed controller-converter selection and Characteristics.

SUGGESTED READINGS

1. Gopal K Dubey, Fundamentals of , lectric Drive Narosa Publishing house, II Edition , 2011
2. B.K Bose, Modern Power Electronics and AC Drives , Pearson Education, 3rd Reprint , 2002
3. S.K. Pillai, A First course on Electrical Drives, Wiley Eastern Limited- Reprint of 3rd edition, 2014

Semester – IV

21PBEEE402 TRANSMISSION AND DISTRIBUTION SYSTEMS 3H-3C

Instruction Hours / week: L: 3 T:0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study the structure of electric power system and to develop expressions for the computation of transmission line parameters.
- To obtain the equivalent circuits for the transmission lines based on distance and to determine voltage regulation and efficiency.
- To study the types, construction of cabilitys and methods to improve the efficiency.
- To study the fault currents for different types of faults
- To study the generation of over-voltages and insulation coordination.
- To understand the mechanical design of transmission lines and to analyze voltage distribution in insulator strings to improve the efficiency.

Course Outcomes (COs)

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

1.Understand the concepts of power systems.
2. Understand the various power system components.
3. Evaluate fault currents for different types of faults.
4. Understand the generation of over-voltages and insulation coordination.
5. Understand basic protection schemes.
6. Understand concepts of HVdc power transmission and renewable energy generation.

UNIT I INTRODUCTION

Structure of electric power system: Generation, transmission and distribution; HVDC and EHV AC transmission: comparison of economics of transmission, technical performance and reliability, application of HVDC transmission system.

UNIT II TRANSMISSION LINE PARAMETERS

Parameters of single and three phase transmission lines with single and double circuits: Resistance, inductance and capacitance of solid, stranded and bundled conductors: Symmetrical and unsymmetrical spacing and transposition; skin and proximity effects; interference with neighbouring communication circuits. Typical configuration, conductor types and electrical parameters of 400, 220, 110, 66 and 33 kV lines.

UNIT III MODELING AND PERFORMANCE OF TRANSMISSION LINE

Classification of lines: Short, medium and long line; equivalent circuits, attenuation constant, phase constant, surge impedance; transmission efficiency and voltage regulation; real and reactive power flow in lines: Power-angle diagram; surge-impedance loading, loadability limits based on thermal loading, angle and voltage stability considerations; shunt and series compensation; Ferranti effect and corona loss. Sag computations. FACTS (qualitative treatment only): SVC, TCSC, STATCOM and UPFC.

UNIT IV INSULATORS AND CABLES

Insulators: Types, voltage distribution in insulator string and grading, improvement of string efficiency. Underground cables: Constructional features of LT and HT cables, capacitance, dielectric stress and grading, thermal characteristics.

UNIT V SUBSTATION, GROUNDING SYSTEM AND DISTRIBUTION SYSTEM

Types of substations: bus-bar arrangements; substation bus schemes: single bus scheme, double bus with double breaker, double bus with single breaker, main and transfer bus, ring bus, breaker-and-a-half with two main buses, double bus-bar with bypass isolators. Resistance of grounding systems: Resistance of driven rods, resistance of grounding point electrode, grounding grids, design principles of substation grounding system; neutral grounding. Radial and ring-main distributors, interconnectors. AC distribution: AC distributor with concentrated load; three-phase four wire distribution system sub-mains;

stepped and tapered mains.

SUGGESTED READINGS

1. Hadi Saadat, Power System Analysis, Tata McGraw Hill Publishing, New Delhi Company 2003
2. V.K.Metha Rohit Metha, Principles of power system, S.Chand & co, New Delhi, 2010
3. Singh, S. N, Electric Power Generation, Transmission and Distribution, Prentice Hall of India Pvt. Ltd, New Delhi, 2002

Semester – IV

21PBEEE403 LINEAR INTEGRATED CIRCUITS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

On completion of the course, students are able to:

- Understand combinational and logical digital circuits and their differences.
- Students will be introduced to Flip-flop, shifts register, counters.
- To learn symbol, working principle of basic Digital electronics circuits for data processing application.
- To study the multiplexer, demultiplexer circuits and demonstrate 555 timer in Monostable and Astable operation.
- To study the Design and demonstrate inverting amplifier, non-inverting amplifier, adder, comparator, integrator and differentiator circuits using Op-Amp.
- At the end of this course, students should be able to recognize and analyze the basic digital circuits.

Course Outcomes (COs)

1.Verify the truth table of Logic Gates and Flip Flops.
2.Apply Boolean functions to implement adder, subtractor circuits and convert Excess 3 to BCD, Binary to Gray code and vice versa.
3.Design parity generator, parity checker, encoder and decoder circuits.
4.Design and implement 4-bit modulo synchronous, Asynchronous counters and implement 4-bit shift registers in SISO, SIPO, PISO, PIPO modes.
5. Explain multiplexer, demultiplexer circuits and demonstrate 555 timer in Monostable and Astable operation.
6. Design and demonstrate inverting amplifier, non-inverting amplifier, adder, comparator, integrator and differentiator circuits using Op-Amp.

UNIT I IC FABRICATION

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities. Realisation of monolithic ICs and packaging. Fabrication of diodes, capacitance, resistance and FETs.

UNIT II CHARACTERISTICS OF OP-AMP

Ideal OP-AMP characteristics, DC characteristics, AC characteristics,, differential amplifier; frequency response of OP-AMP; Basic applications of op-amp – Inverting and Non-inverting Amplifiers-V/I & I/V converters ,summer, differentiator and integrator.

UNIT III APPLICATIONS OF OP-AMP

Instrumentation amplifier, Log and Antilog Amplifiers, first and second order active filters, ,

comparators, multivibrators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/A converter (R- 2R ladder and weighted resistor types), A/D converters using op-amps.

UNIT IV SPECIAL ICs

Functional block, characteristics & application circuits with 555 Timer Ic-566 voltage controlled oscillator Ic; 565-phase lock loop Ic ,Analog multiplier ICs.

UNIT V APPLICATION ICs

IC voltage regulators –LM78XX,79XX Fixed voltage regulators - LM317, 723 Variable voltage regulators, switching regulator- SMPS- LM 380 power amplifier- ICL 8038 function generator IC.

SUGGESTED READINGS

1 David A.Bell, Op-amp & Linear ICs, Oxford, 2010
2. D.Roy Choudhary, Sheil B.Jani, Linear Integrated Circuits, New Age, 2003
3. Ramakant A.Gayakward, Op-amps and Linear Integrated Circuits, Pearson Education , 2003
4. Fireo, Opamps & Linear Integrated Circuits Concepts & Applications, Cengage, 2003

Semester – IV

21PBEEE404 POWER PLANT ENGINEERING 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To learn the economics connected with power generation.
- To understand the measurements of various parameter in power plant and their control.
- To study about Powerplant instrumentation
- To acquire knowledge of renewable power system
- To study about technologies of distributed system
- To study layout and working of thermal, nuclear and hydropower plants.

Course Outcomes:

At the end of the course the student will gain knowledge about

1. The student also gain knowledge about distributed generation, boiler turbine monitoring system.
2. To get knowledge in Powerplant instrumentation
3. Students acquire knowledge of renewable power system
4. Gather knowledge in layout and working of thermal, nuclear and hydropower plants.
5. Acquire knowledge in cost and tariff of energy
6. Economics of power Generation

UNIT I ECONOMICS OF POWER GENERATION

Choice of power plant; Load management; Number and size of generating unit; Cost of electrical energy; All types of tariff – Calculation – Power factor improvement.

UNIT II THERMAL POWER PLANT

Plant layout; Selection of site – Types of thermal power plants; Steam power plant based on fossil fuels; Thermal power plant equipment: Boiler, economizer, super heater, condenser, combustion chamber and gas loops, turbines, auxiliaries; Instrumentation and control; Heat balance.

UNIT III GAS POWER PLANT

Open and close cycles; Regeneration; Inter–cooling and reheating; Steam – gas power plant; Combined cycle power plant ; Plant protection ; Instrumentation and Control; Plant management; Plant layout; Optimized Generation; Load flow.

UNIT IV HYDRO POWER PLANT

Mass curve and storage capacity; Classification; Components; Turbines – Characteristics and their selection; Governor; Plant layout and design; Auxiliaries; Underground, automatic, remote controlled, and pumped storage plants. Optimized Generation.

UNIT V NUCLEAR AND DIESEL – ELECTRIC POWER PLANTS

Nuclear reactors and fuels; Radioactivity; Mass defect and binding energy; Chain reaction; Materials used in nuclear plants; Types of reactors. Diesel–electric Power Plant: Fields of use; Sub–systems; Starting and stopping; Heat balance; Plant layout and design; Remote operation; Auxiliaries.

SUGGESTED READINGS

1. Black and Veatch, Power Plant Engineering, CBS Publishers & Distributors, 2005

2. Gupta, B. R., Generation of Electrical Energy, S . C h a n d P u b l i s h i n g , N e w D e l h i 14th Edition, 2012

3. Deshpande, M. V., Elements of Power Station Design , PHI Learning Pvt. Ltd. – reprint, 2010

Semester – IV

21PBEEE411 POWER ELECTRONICS AND DRIVES LABORATORY 3H-2C

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study the characteristics of switching devices and its applications in rectifier inverter, chopper and resonant converter.
- To study about power electronic circuits
- To study about industrial control of power electronic circuits
- To study about the various characteristic of SCR and TRIAC
- To study about the various characteristic of PWM inverter
- To study power electronic circuits for different loads

Course Outcomes (COs)

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

1. The students will be able to demonstrate the all power semiconductor devices.
2. To expose students to operation and characteristics of power semiconductor devices and passive components, their practical application in power electronics.
3. To provide a practical exposure to operating principles, design and synthesis of different power electronic converters.
4. To introduce students to industrial control of power electronic circuits as well as safe electrical connection and measurement practices.
5. Able to analyze power electronics circuits
6. Able to apply power electronic circuits for different loads

LIST OF EXPERIMENTS:

1. Gate Pulse Generation using R,RC and UJT.
2. Characteristics of SCR and Triac
3. Characteristics of MOSFET and IGBT
4. AC to DC half controlled converter
5. AC to DC fully controlled Converter
6. Step down and step up MOSFET based choppers
7. IGBT based single phase PWM inverter

8. IGBT based three phase PWM inverter

9. AC Voltage controller

10. Switched mode power converter.

11. Simulationof PEcircuits(1Φ&3Φsemiconverter,1Φ&3Φfullconverter,dc-dc converters, ac voltage controllers).

SUGGESTED READINGS

1. Rashid Muhammad, H., "Power Electronics: Circuits, Devices and Applications", 2nd Ed. Prentice-Hall,
1998.
2. Mohan Ned, Undeland Tore, M. and Robbins William, P., "Power Electronics: Converter, Applications and
Design", John Wiley & Sons, 1994.
3. Landev Cyrill, W., "Power Electronics", McGraw Hills, London, 1981.
4. Dewan, S.B. and Satrughan A., "Power Semiconductor Circuits", John Wiley & Sons, 1975.

Semester – V

21PBEEE501 **HIGH VOLTAGE ENGINEERING** **3H-3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To understand the various types of over voltages in power system and Protection methods.
- To study about generation of over voltages in laboratories.
- To know about measurement of over voltages.
- To study about the nature of Breakdown mechanism in solid, liquid and gaseous dielectrics -discussion on commercial insulates.
- To study about testing of power apparatus and insulation coordination
- To study the AC and DC high voltage and current using CVT

Course Outcomes (COs)

At the end of the course, the student will demonstrate

1. Identify the causes of over voltages and its effects and estimate the reflection and refractions of travelling waves in transmission lines
2. Discuss the various types of breakdown mechanisms and analyze the breakdown mechanisms in solid, liquid, gases and composite dielectrics
3. Explain the generation and design of different types of Generating circuits for high voltage and currents of AC, DC and impulse
4. Measure AC and DC high voltage and current using high resistance with series ammeter, dividers, peak voltmeter and generating voltmeters
5. Discuss the testing methodologies related to various high voltage equipment with reference to national and international standards
6. Estimate the AC and DC high voltage and current using CVT, electrostatic voltmeters, sphere gaps, high current shunts and digital techniques in high voltage measurement

.

UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS

Causes of over voltages and its effect on power system – Lightning, switching surges and temporary over voltages – protection against over voltages.

UNIT II ELECTRICAL BREAKDOWN IN GASES, LIQUIDS AND SOLID

Gaseous breakdown in uniform and non–uniform fields – corona discharges – Vacuum breakdown – conduction and breakdown in pure and commercial liquids – breakdown mechanisms in solid and composite dielectrics.

UNIT III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS

Generation of High DC, AC, impulse voltages and currents. Tripping and control of

impulse generator.

UNIT IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENT

Measurement of High voltages and High currents – digital techniques in high voltage measurement.

UNIT V HIGH VOLTAGE TESTING AND INSULATION COORDINATION

High voltage testing of electrical power apparatus – power frequency, impulse voltage and DC testing – International and Indian standards – Insulation Coordination

SUGGESTED READINGS

1. Naidu, M. S and Kamaraju, V , High Voltage Engineering, Tata McGraw Hill, New Delhi, 2004
2. Kuffel, E. and Zaengl, W. S, High Voltage Engineering Fundamentals , Butterworth-Heinemann 2000
3.Abdel–AlAm/Ani

Semester – V

21PBEEE502 POWER SYSTEM ANALYSIS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study the structure of electric power system and to develop expressions for the computation of transmission line parameters.
- To obtain the equivalent circuits for the transmission lines based on distance and to determine voltage regulation and efficiency.
- To study the types, construction of cabilitys and methods to improve the efficiency.
- To study the fault currents for different types of faults
- To study the generation of over-voltages and insulation coordination.
- To understand the mechanical design of transmission lines and to analyze voltage distribution in insulator strings to improve the efficiency.

Course Outcomes (COs)

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

1.Understand the concepts of power systems.
2. Understand the various power system components.
3. Evaluate fault currents for different types of faults.
4. Understand the generation of over-voltages and insulation coordination.
5. Understand basic protection schemes.
6. Understand concepts of HVdc power transmission and renewable energy generation

UNIT I THE POWER SYSTEM – AN OVERVIEW AND MODELING

Modern Power System - Basic Components of a power system - Per Phase Analysis Generator model - Transformer model - line model. The per unit system -Change of base.

UNIT II POWER FLOW ANALYSIS

Introduction - Bus Classification - Bus admittance matrix, Nodal method, Singular transformation method without mutual coupling - Solution of non-linear Algebraic equations - Gauss Seidal method - Newton Raphson method - Fast decoupled method - Flow charts and comparison of the three methods.

UNIT III FAULT ANALYSIS - BALANCED FAULT

Introduction – Balanced three phase fault – short circuit capacity – systematic fault analysis using bus impedance matrix – algorithm for formation of the bus impedance matrix.

UNIT IV FAULT ANALYSIS – SYMMETRICAL COMPONENTS AND UNBALANCED FAULT

Introduction – Fundamentals of symmetrical components – sequence impedances – sequence networks – single line to ground fault – line fault - Double line to ground fault – Unbalanced fault analysis using bus impedance matrix.

UNIT V POWER SYSTEM STABILITY

Basic concepts and definitions – Rotor angle stability – Voltage stability – Mid Term and Long Term stability – Classification of stability – An elementary view of transient stability – Equal area criterion – Reponses to a short circuit fault- factors influencing transient stability – Numerical integration methods – Euler's method – modified Euler's method – Runge Kutta methods.

SUGGESTED READINGS

1. Hadi Saadat, Power System Analysis, Tata McGraw Hill Publishing Company, New Delhi., 2002
2. Olle I Elgerd, Electric Energy Systems Theory – An Introduction, Tata McGraw Hill, New Delhi., 2003
3. Kundur, P, Power System Stability and Control, Tata McGraw Hill Publications, 2010.

Semester – V

21PBEEE511 ELECTRONICS LABORATORY 3H-2C

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

On completion of the course, students are able to:

- Understand combinational and logical digital circuits and their differences.
- Students will be introduced to Flip-flop, shifts register, counters.
- To learn symbol, working principle of basic Digital electronics circuits for data processing application.
- To study the multiplexer, demultiplexer circuits and demonstrate 555 timer in Monostable and Astable operation.
- To study the Design and demonstrate inverting amplifier, non-inverting amplifier, adder, comparator, integrator and differentiator circuits using Op-Amp.
- At the end of this course, students should be able to recognize and analyze the basic digital circuits.

Course Outcomes (COs)

1.Verify the truth table of Logic Gates and Flip Flops.

2.Apply Boolean functions to implement adder, subtractor circuits and convert Excess 3 to BCD, Binary to Gray code and vice versa.

3.Design parity generator, parity checker, encoder and decoder circuits.

4.Design and implement 4-bit modulo synchronous, Asynchronous counters and implement 4-bit shift registers in SISO, SIPO, PISO, PIPO modes.

5. Explain multiplexer, demultiplexer circuits and demonstrate 555 timer in Monostable and Astable operation.

6. Design and demonstrate inverting amplifier, non-inverting amplifier, adder, comparator, integrator and differentiator circuits using Op-Amp.

LIST OF EXPERIMENTS

1. Static characteristics of semiconductor diode and Zener diode.
2. Static Characteristics of transistor configuration.
3. Static and transfer characteristics of JFET.
4. Static characteristics of UJT.
5. RC Phase shift oscillator.
6. Verification of truth table of Logic Gates and Flip Flops.
7. Implementation of Boolean Functions, Adder and Subtractor circuits.
8. Study of NE/SE 555 timer in Astable and Monostable operation.

9. Inverting and non–inverting amplifiers, Adder and comparator using Op–Amps.
10. Integrator and Differentiator using Op–Amps.
11. Simple arithmetic operations using 8085
    Multi precision addition / subtraction / multiplication / division
12. Simple Interfacing experiments using 8251, 8279 and 8254.

Semester –V

21PBEEE591	**Mini Project**	**3H-1C**

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: 100 External: 0 Total: **100**

End Semester Exam: 3 Hours

Semester –VI

21PBEEE601 POWER SYSTEM OPERATION AND CONTROL 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To model the power system under steady state operating condition
- To understand and apply iterative techniques for power flow analysis
- To model and carry out short circuit studies on power system
- To model and analyze stability problems in power system
- To study the monitoring and control of a power systems.
- To study the basics of power system economics.

Course Outcomes (COs)

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

1.Use numerical methods to analyse a power system in steady state.
2. Understand stability constraints in a synchronous grid.
3. Understand methods to control the voltage, frequency.
4. Understand methods to control the power flow.
5. Understand the monitoring and control of a power system.
6. Understand the basics of power system economics.

UNIT I INTRODUCTION

System load variation: System load characteristics, load curves - daily, weekly and annual, load-duration curve, load factor, diversity factor. Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves. Overview of system operation: Load forecasting, unit commitment, load dispatching. Overview of system control: Governor Control, LFC, EDC, AVR, system voltage control, security control.

UNIT II REAL POWER - FREQUENCY CONTROL

Fundamentals of speed governing mechanism and modeling: Speed-load characteristics – Load sharing between two synchronous machines in parallel; concept of control area, LFC control of a single-area system: Static and dynamic analysis of uncontrolled and controlled cases, Economic Dispatch Control. Multi-area systems: Two-area system modeling; static analysis, uncontrolled case; tie line with frequency bias control of two-area system derivation.

UNIT III REACTIVE POWER–VOLTAGE CONTROL

Typical excitation system, modeling, static and dynamic analysis, stability compensation; generation and absorption of reactive power: Relation between voltage, power and reactive power at a node; methods of voltage control: Injection of reactive power. Tap-changing transformer, numerical problems - System level control using generator voltage magnitude setting, tap setting of OLTC transformer and MVAr injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

UNIT IV UNIT COMMITMENT AND ECONOMIC DISPATCH

Statement of Unit Commitment (UC) problem; constraints in UC: spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints; UC solution methods: Priority-list methods, forward dynamic programming approach, numerical problems only in priority-list method using full-load average production cost. Incremental cost curve, co-ordination equations without loss and with loss, solution by direct method and λ-iteration method. (No derivation of loss coefficients) Base point and participation factors. Economic dispatch controller added to LFC control.

UNIT V COMPUTER CONTROL OF POWER SYSTEMS

Energy control centre: Functions – Monitoring, data acquisition and control. System hardware configuration – SCADA and EMS functions: Network topology determination, state estimation, security analysis and control. Various operating states: Normal, alert, emergency, inextremis and restorative. State transition diagram showing various state transitions and control strategies.

SUGGESTED READINGS

1. Allen J Wood and Bruce F Wollenberg, Power Generation, Operation and Control, John Wiley and Sons, Inc.. 2003

2. Kothari, D.P. and Nagrath, I.J.,, Modern Power System Analysis, Tata McGraw Hill Publishing Company Limited, New Delhi.3rd Edition, 2003

3. Kundur, P, Power System Stability and Control, Tata McGraw Hill Publications, 2010.

Semester – VI

21PBEEE602 ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT

3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To know the fundamentals of cost analysis and economics.
- To learn about the basics of economics and cost analysis related to engineering so as to take economically sound decisions.
- To make the students to understand capital market, break-even point analysis and depreciation
- To know economic evaluation and financial analysis of investments and projects.
- To know the financial management and stock exchanges.
- To know the Cost analysis of Markets

Course Outcomes (COs)

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

1. Understand the principles and basic concepts.
2. Understand the fundamentals of cost analysis and economics.
3. Understand the methodology of engineering economy and source of finance
4. Perform economic evaluation and financial analysis of investments and projects.
5. Analyse the financial management and stock exchanges.
6. Analyse the capital market, break even point analysis and depreciation for a project.

UNIT I FUNDAMENTALS OF ENGINEERING ECONOMICS

Introduction to Engineering Economics – Definition and Scope – Significance of Engineering Economics- Demand and supply analysis-Definition – Law of Demand – Elasticity of Demand – Demand Forecasting. Supply – Law of supply – Elasticity of Supply.

UNIT II FINANCIAL MANAGEMENT

Objectives and functions of financial management – financial statements, working capital management– factors influencing working capital requirements – estimation of working capital. Capital budgeting - Need for Capital Budgeting – Project Appraisal Methods - Payback Period – ARR – Time Value of Money.

UNIT III CAPITAL MARKET

Stock Exchanges – Functions – Listing of Companies – Role of SEBI – Capital Market Reforms. Money and banking - Money – Functions –Inflation and deflation – Commercial Bank and its functions – Central bank and its functions.

UNIT IV NEW ECONOMIC ENVIRONMENT

National Income – concepts – methods of calculating national income - Economic systems, economic Liberalization –Privatization – Globalization. An overview of International Trade – World Trade Organization – Intellectual Property Rights.

UNIT V COST ANALYSIS AND BREAK EVEN ANALYSIS

Cost analysis - Basic cost concepts – FC, VC, TC, MC – Cost output in the short and long run. Depreciation - meaning – Causes – Methods of computing Depreciation (simple problems in Straight Line Method, Written Down Vale Method). Meaning – Break Even Analysis - Managerial uses of BEA.

SUGGESTED READINGS

1 Ramachandra Aryasri .A, and V. V.Ramana Murthy, Engineering Economics & Financial Accounting , Tata McGraw Hill,–,New Delhi, 2007

2. Varshney R. L., and K.L Maheshwari, Managerial Economics, Sultan Chand & Sons, New Delhi , 2001

3. M.L.Jhingan, Principles of Economics, Konark Publications, 2010

Semester – VI

21PBEEE611 POWER SYSTEM SIMULATION LABORATORY 3H-2C

Instruction Hours / week: L: 0 T:0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

Students will learn

- The various line parameters
- The voltage regulation and efficiency of different types of transmission lines.
- A network under symmetrical fault conditions and interpret the results
- A network under unsymmetrical fault conditions and interpret the results
- The Bus impedance and admittance Matrix
- Acquire software development skills and experience in the usage of standard package necessary for analysis and simulation of power system required for its planning, operation and control.

Course Outcomes (COs)

1. Analyze the various line parameters
2. Evaluate the voltage regulation and efficiency of different types of transmission lines.
3. Analyze a network under symmetrical fault conditions and interpret the results
4. Analyze a network under unsymmetrical fault conditions and interpret the results
5. Evaluate the Bus impedance Matrix
6. Evaluate the Bus admittance Matrix

LIST OF EXPERIMENTS

1. Computation of Parameters and Modeling of Transmission Lines.
2. Formation of Bus Admittance and Impedance Matrices and Solution of Networks.
3. Load Flow Analysis - I: Solution of Load Flow and related Problems using Gauss-Seidel Method
4. Load Flow Analysis - II: Solution of Load Flow and related Problems using Newton-Raphson and Fast-Decoupled Methods
5. Study of symmetrical and unsymmetrical Fault Analysis.
6. Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System
7. Transient Stability Analysis of Multi-machine Power Systems
8. Electromagnetic Transients in Power Systems.
9. Load – Frequency Dynamics of Single- Area and Two-Area Systems.
10. Economic Dispatch in Power Systems without considering transmission losses.
11. Economic Dispatch in Power Systems with transmission losses.

SUGGESTED READINGS

1. Allen J Wood and Bruce F Wollenberg, Power Generation, Operation and Control, John Wiley and Sons, Inc.. 2003

2. Kothari, D.P. and Nagrath, I.J.,, Modern Power System Analysis, Tata McGraw Hill Publishing Company Limited, New Delhi.3rd Edition, 2003

3. Kundur, P, Power System Stability and Control, Tata McGraw Hill Publications, 2010.

Semester –V

21PBEEE691 Project Work and Viva-Voce Phase 1 3H-3C

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: 40 External: 60 Total: **100**

End Semester Exam: 3 Hours

Semester – VII

21PBEEE701 TOTAL QUALITY MANAGEMENT 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objective

- To understand the Total Quality Management concept and principles and the various tools available to achieve Total Quality Management.
- To understand the statistical approach for quality control.
- To create an awareness about the ISO and QS certification process and its need for the industries.
- To learn the concepts of total quality management.
- To learn the concepts of total education
- To learn problems in the quality improvement process,SPC etc

Course Outcome

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

1. Understand the principles and basic concepts.
2. Understnd the fundamentals of quality controls.
3. Explain the concepts of total quality management.
4. Explain the concepts of total education
5. Diagnose problems in the quality improvement process,SPC etc.
6. Diagnose problems in the production planning,control and decision making.

.

UNIT I INTRODUCTION

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management (TQM), Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT II TQM PRINCIPLES

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Triology, PDSA Cycle, 5S Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy and Performance Measures.

UNIT III STATISTICAL PROCESS CONTROL

The seven QC tools, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV TQM TOOLS

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance – Concept, Improvement Needs, FMEA – Stages of FMEA.

UNIT V QUALITY SYSTEMS

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

SUGGESTED READINGS

1 Dale H Besterfiled, Total Quality Management, Pearson Education, Inc., New Delhi, 2003

2. Narayana, V. and Sreenivasan, N.S, Quality Management – Concepts and Tasks, New Age International, New Delhi – reprint, 2007

3. James R Evans and William M Lidsay, The Management and Control of Quality, South–Western Thomson Learning, United States – 8th edition, 2011

Semester –VII

21PBEEE791 Project Work and Viva-Voce Phase 2 3H-6C

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: 120 External: 180 Total: 3**00**

End Semester Exam: 3 Hours

Semester – V

21PBEEE5E01 DATA STRUCTURES AND ALGORITHMS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

Students will learn

- Application of stacks and queues
- Different types of ADT
- Different data analysis
- Different algorithm design and analysis
- Different algorithm for graphs
- Recent trends

Course Outcomes

Students will understand

1. Application of stacks and queues
2. Different types of ADT
3. Different data analysis
4. Different algorithm design and analysis
5. Different algorithm for graphs
6. Design and applications of linear, tree, and graph structures

UNIT I INTRODUCTION TO DATA STRUCTURES

Abstract data types - Sequences as value definitions - Data types in C - Pointers in C - Data structures and C - Arrays in C - Array as ADT - One dimensional array - Array as parameters - Two dimensional array -Structures in C - Implementing structures - Unions in C - Implementation of unions -Structure parameters - Allocation of storage and scope of variables. Recursive definition and processes: Factorial function - Fibonacci sequence
- Recursion in C - Efficiency of recursion.

UNIT II STACK, QUEUE AND LINKED LIST

Stack definition and examples – Primitive operations – Example - Representing stacks in C - Push and pop operation implementation. Queue a s ADT - C Implementation of queues - Insert operation - Priority queue - Array implementation of priority queue. Inserting and removing nodes from a list-linked implementation of stack, queue and priority queue - Other list structures - Circular lists: Stack and queue as circular list - Primitive operations on circular lists. Header nodes - Doubly linked lists - Addition of long positive integers on circular and doubly linked list.

- To know the practical application for power electronics converters in conditioning the power supply.

Course Outcomes (COs)

1. The students will have the ability to understand and analyse,converters and its applications

UNIT III TREES

Binary trees: Operations on binary trees - Applications of binary trees - Binary tree representation - Node representation of binary trees - Implicit array representation of binary tree – Binary tree traversal in C – Threaded binary tree – Representing list as binary tree – Deleting an element. Trees and their applications: C representation of trees - Tree traversals - Evaluating an expression tree - Constructing a tree.

UNIT IV SORTING AND SEARCHING

General background of sorting: Efficiency considerations, Notations, Efficiency of sorting. Exchange sorts: Bubble sort; Quick sort; Selection sort; Binary tree sort; Heap sort. Heap as a priority queue – Sorting using a heap-heap sort procedure – Insertion sorts: Simple insertion - Shell sort – Address calculation sort – Merge sort – Radix sort Sequential search: Indexed sequential search - Binary search - Interpolation search

UNIT V GRAPHS

Application of graphs - Representation of graphs - Transitive closure - Warshall's algorithm – Shortest path algorithm – Linked representation of graphs - Dijkstra's algorithm - Graph traversal - Traversal methods for graphs - Spanning forests - Undirected graph and their traversals - Depth first traversal - Application of depth first traversal - Efficiency of depth first traversal - Breadth first traversal - Minimum spanning tree – Kruskal's algorithm – Round robin algorithm.

SUGGESTED READINGS

1. Aaron M. Tenenbaum, Yeedidyah Langsam and Moshe J Augenstein Data structures using C Prentice Hall of India Private Ltd., New Delhi 2012
2. Aho, V., Jeffrey D Ullman, and John E Hopcroft Data Structures and Algorithms Addison–Wesley, New York 2011

UNIT I POWER SEMI CONDUCTOR DEVICES

Silicon Controlled Rectifier(SCR),TRIAC,DIAC - Structure, V-I Characteristics - Two Transistor Model, Structure and characteristics of Power Diode, Power BJT, MOSFET, IGBT, GTO, Comparisons of Power Semiconductor Devices Firing circuits.

UNIT II PHASE CONTROLLED CONVERTERS

Operation and Analysis of Single Phase Half Controlled Converter using R, RL load- Three Phase Half and Fully Controlled Converter using R, RL load-Effects of Source Impedance, Dual converter (only Block diagram approach).

UNIT III CHOPPERS

Step-Down and Step-up Choppers-Control Strategies of Chopper – Multi Quadrant Operation of Chopper- Switched Mode Regulators: Buck, Boost, Buck-Boost Regulator- Applications of DC Chopper.

UNIT V AC-AC CONVERTER

Single phase half bridge and full bridge inverters- three phase bridge inverters (120 and 180 degree mode of operation)- Voltage control of inverters- Pulse width modulation techniques - Single PWM, multiple PWM, sinusoidal PWM, modified PWM.

UNIT V AC-AC CONVERTER AND APPLICATIONS

Single phase cyclo converter, Single phase AC voltage controller- Applications- Uninterrupted Power Supply topologies (Off line and On line) – Flexible AC Transmission Systems –Unified Power Flow Controller– HVDC Transmission

SUGGESTED READINGS

1. Rashid, Muhammad, H., "Power Electronics: Circuits, Devices and Applications", 2nd Ed, Prentice-Hall, 1998.
2. Mohan Ned, Undeland Tore, M. and Robbins William, P., "Power Electronics: Converter, Applications and Design", John Wiley & Sons, 1994.
3. Landev Cyrill, W., "Power Electronics", McGraw Hills, London, 1981.
4. Dewan, S.B. and Satrughan A., "Power Semiconductor Circuits", John Wiley & Sons, 1975.

Semester – V

21PBEEE5E02 COMPUTER NETWORKS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study about various network architecture
- To study and analyze about various switching.
- To study about web security and its need
- To study about protocols and its controls
- To study about subnetting and domains basics
- To study about real time need of network management

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Course Outcomes (COs)

At the end of the course the student will be able

- To understand the computer networks and network protocols.
- To gain switching mechanisms of various interlink networks
- To know web securities and its need in real time digital world
- To gather D-link concepts
- To acquire wireless communication software and its related devices
- Gather protocols of dealing network accessories

UNIT I INTRODUCTION

Network architecture – layers – Physical links – Channel access on links – Hybrid multiple access techniques - Issues in the data link layer - Framing – Error correction and detection – Link-level Flow Control

UNIT II WIRELESS NETWORKS

Medium access – CSMA – Ethernet – Token ring – FDDI - Wireless LAN – Bridges and Switches

UNIT III SWITCHING

Circuit switching vs. packet switching / Packet switched networks – IP – ARP – RARP – DHCP – ICMP – Queueing discipline – Routing algorithms – RIP – OSPF – Subnetting – CIDR – Interdomain routing – BGP – Ipv6 – Multicasting – Congestion avoidance in network layer

UNIT IV NETWORK PROTOCOLS

UDP – TCP – Adaptive Flow Control – Adaptive Retransmission - Congestion control – Congestion avoidance – QoS

UNIT V WEB SECURITY

Email (SMTP, MIME, IMAP, POP3) – HTTP – DNS- SNMP – Telnet – FTP – Security – PGP – SSH

SUGGESTED READINGS

1. Larry L. Peterson, Bruce S. Davie Computer Networks: A Systems Approach Third Edition, Morgan Kauffmann Publishers Inc , 2003
2. Nader F. Mir , Computer and Communication Netwroks, Pearson Edition ,2007
3. Comer, Computer Networks, Fourth Edition,,2003

Semester – V

21PBEEE5E03 NETWORK ANALYSIS AND SYNTHESIS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

Students will able

- To understand the concept of network analysis.
- To understand the basic principles of network theorems.
- To study the electrical circuits using Laplace Transforms
- To study the transient and steady-state response of electrical circuits.
- To study the sinusoidal steady-state (single-phase and three-phase).
- To get the knowledge of two port circuit behavior.

Course Outcomes

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

1. Apply network theorems for the analysis of electrical circuits.
2. Obtain the solution of first and Second order system
3. Analyse the electrical circuits using Laplace Transforms.
4. Obtain the transient and steady-state response of electrical circuits.
5. Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
6. Analyse two port circuit behavior.

UNIT-I INTRODUCTION

Circuits elements, Independent and dependent sources, signals and wave forms; periodic and singularity voltages, step, ramp, impulse, Doublet. Development of circuit concept, Conventions for describing networks.

UNIT-II GRAPH THEORY

Graph of a Network, definitions, tree, co tree, link, basic loop and basic cut set, Incidence matrix, cut set matrix, Tie set matrix Duality, Loop and Node methods of analysis.

UNIT-III NETWORK THEOREMS (APPLICATIONS TO AC NETWORKS)

Super-position theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, Reciprocity theorem. Millman's theorem, compensation theorem, Tellegen's theorem.

UNIT-IV FILTERS SYNTHESIS

Classification of filters, Ladder network, T section, IT section, terminating half section. Pass bands and stop bands. Design of constant-K, m-derived filters. Composite filters.

UNIT-V NETWORK SYNTHESIS

Positive real function, definition and properties; Properties of LC, RC and RL driving point functions, synthesis of LC, RC and RL driving point admittance functions using Foster and Cauer first and second forms.

SUGGESTED READINGS

1. S Chakraborty Ghosh A, Network Analysis & Synthesis, Tata Mcgraw Hill 1st edition, 2009
2. Gobind Daryanani, Principles of Active Network Synthesis & Design, Wiley India Pvt Ltd, 2009
3. M.E. Van Valkenburg, Network Analysis, Phi Learning - 3rd Edition,2014

Semester – V

21PBEEE5E04 SPECIAL ELECTRICAL MACHINES 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To expose the students to the concepts of special electrical machines and analyze their performance and to impart knowledge on
- Construction and performance of synchronous reluctance motors.
- Principle of operation and performance of stepping motors .
- To study the knowledge on construction and operation of permanent magnet brushless D.C. motors.
- To study the real time need of special machines
- Construction, principle of operation and performance of switched reluctance motors, permanent magnet synchronous motors.

Course Outcomes

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

1. Analyze and design controllers for special Electrical Machines.
2. Acquire the knowledge on construction and operation of stepper motor.
3. Understand the concept of construction and operation of stepper switched reluctance motors.
4. Acquire the knowledge on construction and operation of permanent magnet brushless D.C. motors.
5. Acquire the knowledge on construction and operation of permanent magnet synchronous motors.
6. Determine a special Machine for a particular application.

UNIT I SYNCHRONOUS RELUCTANCE MOTORS

Constructional features – Types – Axial and radial air gap motors – Operating principle – Reluctance – Phasor diagram – Characteristics – Vernier motor – Driver circuits – Applications of AC motors.

UNIT II STEPPING MOTORS

Construction and Principle of operation – Types: Permanent Magnet, Hybrid and Variable reluctance motor – Single and multi stack configurations – Theory of torque predictions – Dynamic Characteristics – Driver circuits – Applications of stepper motors.

UNIT III SWITCHED RELUCTANCE MOTORS

Construction and Principle of operation – Torque prediction – Power controllers – Non–linear analysis – Microprocessor based control – Characteristics – Driver circuits.

UNIT IV PERMANENT MAGNET BRUSHLESS DC MOTORS

Construction and Principle of operation – Electronic Commutator – Difference between electronic and Mechanical Commutator – Types of PMBLDC motors – Magnetic circuit analysis – EMF and torque equations – Power controllers – Motor characteristics and control – Applications of DC motors.

UNIT V PERMANENT MAGNET SYNCHRONOUS MOTORS

Construction and Principle of operation – EMF and torque equations – Torque-speed characteristics – Reactance – Phasor diagram – Power controllers –Volt-ampere requirements of Converter – Self, Vector and Current control schemes.

SUGGESTED READINGS

1. P.P.Acarnley, Stepping Motors, A Guide to Modern theory and practice Peter Peregrines, London, 2002
2. B K Bose, Modern Power Electronics & AC, Pearson, 2002
3. Sen.P.C, Principles of Electrical Machines and Power Electronics, John willey & Sons, Second edition, 2008

Semester – V

21PBEEE5E05 ENERGY MANAGEMENT, UTILIZATION AND AUDITING 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives:

- To gain the knowledge about energy management.
- To understand the basic concepts in economic analysis in energy management.
- To understand the basic principles of energy audit.
- To gain the knowledge about the basic concept of types of Energy Audit
- To gain and evaluate the different heating, welding & illumination
- Understand the concept of Electric traction.

Course Outcomes:

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

1. understand and analyse the energy data of industries
2. carryout energy accounting and balancing
3. conduct energy audit and suggest methodologies for energy savings
4. understand the principle, design of illumination systems and energy efficiency lamps.
5. analysis the methods of industrial heating and welding.
6. understand the electric traction systems and their performance

UNIT I ENERGY MANAGEMENT

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting –Energy Auditor and Energy Manager – Eligibility, Qualification and functions - Questionnaire and check list for top management.

UNIT II ECONOMIC ASPECTS AND ANALYSIS

Economics analysis – Depreciation Methods, time value of money, Calculation of simple payback, net preset value, internal rate of return, present worth method, replacement analysis, life cycle costing analysis.

UNIT III ILLUMINATION, HEATING AND WELDING

Nature of radiation – definition – laws – photometry – lighting calculations – design of illumination systems (for residential, industrial, commercial, health care, street lightings, sports, administrative complexes) - types of lamps - energy efficiency lamps. Methods of heating, requirement of heating material – design of heating element – furnaces – welding generator – welding transformer and its characteristics.

UNIT IV ELECTRIC TRACTION 9

Introduction – requirements of an ideal traction system – supply systems – mechanics of

train movement – traction motors and control – multiple units – braking – current collection systems – recent trends in electric traction.

UNIT V BASIC PRINCIPLES OF ENERGY AUDIT 9

Energy audit – definition, concept, type of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes – Energy audit of industries – energy saving potential, energy audit of process industry, thermal power station, building energy audit.

SUGGESTED READINGS

1. W.C.Turner Steve Doty, Energy Management Handbook, John Wiley and Sons 7th Edition2009
2. E. Openshaw Taylor, Utilization of Electrical Energy in SI Units', Orient Longman Pvt.Ltd, 2003
3. B.R. Gupta, Generation of Electrical Energy, Eurasia Publishing House (P) Ltd, New Delhi, 2003

Semester – V

21PBEEE5E06 DISTRIBUTED GENERATION 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study about the distributed generation system.
- To study about the relaying and protections in the distributed system.
- To get the knowledge of distributed generation, boiler turbine monitoring system.
- To get the knowledge in Planning of distributed system
- To know the control of DG inverter
- To gather knowledge of protection of distributed systems

Course Outcomes (COs)

At the end of the course the students will

1. Understand the distributed generation system , boiler turbine monitoring system.
2. Understand the Planning of distributed system
3. Analysis the control of DG inverters
4. Analysis the protection of distributed systems
5. Understand the rel time system
6. Analysis the norms and standards used in it

UNIT I INTRODUCTION TO DISTRIBUTED GENERATION

Introduction to the concept of distributed generation - Distributed generation advantages and needs - Radial distribution system protection: Fuse, circuit breakers, reclosers- Per- unit analysis, fault analysis, sequence component analysis, sequence models of distribution system components. Implications of DG on distribution system protection coordination.

UNIT II DISTRIBUTION SYSTEM LOADING

Introduction – Distribution system loading, line drop model, series voltage regulators and on line tap changers- Power quality requirements and source switching using SCR based static switches- Loop and secondary network distribution grids and impact of DG operation.

UNIT III RELAYING AND PROTECTION

Relaying and protection, distributed generation interconnection relaying, sensing using CTs and PTs- Intentional and unintentional islanding of distribution systems. Passive and active detection of unintentional islands, non detection zones - EMI considerations in DG applications.

UNIT IV DISTRIBUTED GENERATION PLANNING

DG planning and forecasting techniques - Load characteristics: Definitions - tariffs and

metering of energy, cost implications of power quality, cost of energy and net present value calculations and implications on power converter design- Distribution Transformers: Types. Distribution sub-stations and primary systems: Voltage drop and power loss calculations: Distribution feeder costs.

UNIT V DG INVERTERS CONTROL

Control of DG inverters, phase locked loops, current control and DC voltage control for stand alone and grid parallel operations. Protection of the converter.

SUGGESTED READINGS

1. Dr. M.K. Khedkar, Dr. G.M. Dhole , A Textbook of Electric Power Distribution Automation, Laxmi Publications,Ltd 2010
2. Ned Mohan, Tore M. Undeland, William P. Robbins, Power Electronics: Converters, Applications, and Design, Wiley, 2002
3. Turan Gonen, Electric Power Distribution Systems, , CRC Press, 2006

Semester – V

21PBEEE5E07 INDUSTRIAL AUTOMATION 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study and gain knowledge about various sensors.
- To study and gain knowledge about controllers.
- To study the concept of sensors,
- To study the concept of actuators
- To study the various tuning controllers
- To study the application of SCADA.

Course Outcomes (COs)

At the end of the course the student will be able to

1. Understand the concept of sensors,
2. Understand the concept of actuators
3. Analyse the various tuning controllers
4. Analyse the various advanced control techniques used in industrial automation.
5. Understand the application of SCADA.
6. Analyse the SCADA usuage in Industries.

UNIT I SENSORS, ACTUATORS

Sensors, Actuators and Signal conditioningSensors: Displacement sensors, Force sensors, Ultrasonic sensors, Temperature sensors, Pressure sensors etc Actuators: Dc motors, Servo motors, Stepper motors, Piezo electric actuators, Pneumatic actuators etc. Signal Conditioning: Filtering, Amplifying, Isolation, ADC, DAC, Sensor protection circuits, Signal transmission and noise suppression, Estimation of errors and calibration.

UNIT II CONTROLLER TUNING

PI controller, PD controller, PID controller and tuning methods: Ziegler-Nichols tuning method, Cohen coon tuning method, Implementation of PID controllers (digital and analog).

UNIT III AUTOMATION

PLC (Programmable logic controllers): Overview, operation and architecture, PLC programming, Application examples. DCS (Distributed control systems): Overview, Advantages, Functional requirements of Distributed control systems, Communication for distributed control

UNIT IV APPLICATIONS

Application examples SCADA (supervisory control and data acquisition): Introduction to SCADA, SCADA system components, architecture and communication, SCADA

applications.

UNIT V ADVANCED CONTROL TECHNIQUES

Feed forward control, Ratio control, Cascade control, Adaptive control, Duplex or split range control, Override control, internal mode control.

SUGGESTED READINGS

1. Krishna Kant, Computer-Based Industrial Control , 2nd edition Prentice Hall of India Ltd, 2003
2. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, TataMcGrawHill, 2009
3. Muhammad Abdelati, Modern Automation Systems, University Science Press , 2009

Semester – V

21PBEEE5E08 CONSUMER ELECTRONICS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study about various speakers and microphone
- To learn the fundamental of television systems and standards
- To learn the process of audio recording and reproduction
- To study various telephone networks
- To discuss about the working of home appliances
- To familiarize with TV services like ISDN.

COURSE OUTCOMES

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

- Understand working of various type of loud speakers
- Acquire knowledge on various types of picture tubes
- Demonstrate the working of various optical recording systems
- Distinguish various standards for color TV system
- Acquire knowledge on various telecommunication networks
- Demonstrate the working of various home appliances

UNIT-I LOUDSPEAKERS AND MICROPHONES

Dynamic Loudspeaker, Electrostatic loudspeaker, Permanent Magnet Loudspeaker, Woofers and Tweeters – Microphone Characteristics, Carbon Microphones, Dynamic Microphones and Wireless Microphones.

UNIT-II TELEVISION STANDARDS AND SYSTEMS

Components of a TV system–interlacing–composite video signal. Colour TV– Luminance and Chrominance signal; Monochrome and Colour Picture Tubes- Color TV systems– NTSC, PAL, SECAM-Components of a Remote Control.

UNIT-III OPTICAL RECORDING AND REPRODUCTION

Audio Disc– Processing of the Audio signal–readout from the Disc –Reconstruction of the audio signal–Video Disc–Video disc formats- recording systems–Playback Systems.

UNIT-IV TELECOMMUNICATION SYSTEMS

Telephone services-telephone networks–switching system principles–PAPX switching–Circuit, packet and message switching, LAN, MAN and WAN, Integrated Services Digital Network.

Wireless Local Loop. VHF/UHF radio systems, Limited range Cordless Phones; cellular modems.

UNIT-V HOME APPLIANCES

Basic principle and block diagram of microwave oven; washing machine hardware and software; Components of air conditioning and refrigeration systems.

SUGGESTED READINGS

1. S.P. Bali Consumer Electronics Pearson Education 1807
2. J.S.Chitode Consumer Electronics Technical Publications 1807
3. Philip Hoff, Philip Herbert Hoff Consumer Electronics for Engineers Cambridge University Press 1898

Semester – VI

21PBEEE6E01 DESIGN OF ELECTRICAL APPARATUS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To provide sound knowledge about constructional details and design of various electrical machines.
- To study mmf calculation and thermal rating of various types of electrical machines.
- To design armature and field systems for D.C. machines.
- To design core, yoke, windings and cooling systems of transformers.
- To design stator and rotor of induction machines.
- To design stator and rotor of synchronous machines and study their thermal behaviour

Course Outcomes (COs)

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

1. Understand the construction of electrical machines.
2. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
3. Understand the principles of electrical machine design
4. carry out a basic design of an AC and DC machine.
5. Use software tools to do design calculations.
6. Understand performance characteristics of electrical machines

UNIT I 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.

UNIT II 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.

UNIT III 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.

UNIT- IV 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.

UNIT V 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.

SUGGESTED READINGS

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.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
4. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969.
5. A. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International, 1979.
6. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

Semester – VI

21PBEEE6E02 DIGITAL LOGIC CIRCUITS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study various number systems , simplify the logical expressions using Boolean functions
- To study implementation of combinational circuits
- To design various synchronous and asynchronous circuits.
- To introduce asynchronous sequential circuits and PLCs
- To study the simple PLC programme
- To understand the real time application of PLC

Course Outcomes (COs)

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

1.Use numerical methods to analyse a power system in steady state.

2. Understand stability constraints in a synchronous grid.

3. Understand methods to control the voltage, frequency.

4.Understand methods to control the power flow.

5.Understand the monitoring and control of a power system.

6. Understand the basics of power system economics

UNIT I NUMBER SYSTEM AND BOOLEAN ALGEBRA

Review of number system; types and conversion, codes. Boolean algebra: De-Morgan's theorem, switching functions and simplification using K-maps and Quine McCluskey method.

UNIT II COMBINATIONAL CIRCUITS

Design of Logic gates. Design of adder, subtractor, comparators, code converters, encoders, decoders, multiplexers and demultiplexers. Function realization using gates and multiplexers.

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS

Flip flops - SR, D, JK and T. Analysis of synchronous sequential circuits; design of synchronous sequential circuits – Counters, state diagram; state reduction; state assignment.

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUIT

Analysis of asynchronous sequential machines, state assignment, asynchronous design problem.

UNIT V PROGRAMMABLE LOGIC DEVICES, MEMORY AND LOGIC FAMILIES

Memories: RAM, ROM, PROM, EPROM, EEPROM, PLA, PAL, PLD, FPGA, and Digital logic families. GATE implementations.

SUGGESTED READINGS

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.

Semester – VI

21PBEEE6E03 HVDC and EHVAC 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To study about HVDC systems
- To study about HVDC control systems
- To Study the control strategies used in HVdc transmission system.
- To Study the improvement of power system stability using an HVdc system.
- To Study and Analysis the components of HVDC system
- To study about aspects of EHVAC systems

Course Outcomes (COs)

At the end of the course the student will

1. Justify the advantages of dc transmission over ac transmission.
2. Reproduce the operation of Line Commutated Converters and Voltage Source Converters.
3. Evaluate the control strategies used in HVdc transmission system.
4. Identify and propose the improvement of power system stability using an HVdc system.
5. gain knowledge about HVDC transmission, converters used and about EHVAC systems.
6. Analysis the real time application of it.

UNIT I EHV TRANSMISSION

Introduction-Necessity for EHV Transmission-Problems involved in EHV Transmission-Operational Aspects of EHV power transmission-Compensation of EHV systems-Gas insulated EHV lines-Environmental and biological aspects.

UNIT II GENERAL BACKGROUND OF EHVAC TRANSMISSION SYSTEMS

Standard Voltage levels for Transmission lines-Hierarchical levels of Transmission Network-Average values of line parameters-Power handling capacity and line losses-Cost of Transmission line and Equipments-Mechanical consideration in line performance-Comparison of Overhead and Underground lines-Examples of Giant power pools in the world.

UNIT III ASPECTS OF EHVAC SYSTEM

Power Transferability of Ac line – Line losses-Conductor cost -Transient stability of Ac line – control of power flow through line Right – of- way(Row)-Corona-Towers(support)-Insulation Coordination and surge arrester protection-Line insulation-Clearance and Creepage distances.

UNIT IV HVDC TRANSMISSION SYSTEMS

Choice of HVDC Transmission - Comparison of AC and DC Transmission – Economics of DC power Transmission, Technical Performance and Reliability – Description of HVDC Converter station- Types of HVDC Links- Merits and Limitations of HVDC System - Applications -Modern Trends in HVDC transmission –Case Studies of HVDC links in the world.

UNIT V CONVERTERS AND HVDC SYSTEM CONTROL

Pulse number – Choice of Converter Configuration – Simplified analysis of Graetz circuit – Principles of HVDC link Control –DC Breaker - Harmonic Elimination – AC and DC Filter design –Protection Systems in HVDC Substation-HVDC Simulator.

SUGGESTED READING

1. K. R. Padiyar, “HVDC Power Transmission Systems”, New Age International Publishers, 2011.
2. J. Arrillaga, “High Voltage Direct Current Transmission”, Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, “Direct Current Transmission”, Vol.1, Wiley-Interscience, 1971.

Semester – VI

21PBEEE6E04 COMPUTER ARCHITECTURE 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives:

- **To study the various representations of data, register transfer language for micro** operations and organization and design of a digital computer.
- To teach the concept of micro–programmed control unit, the central processing unit, stack and instruction formats.
- To Study the various arithmetic operation's algorithms
- To study the hardware implementations and concept of pipelining and vector processing.
- To illustrate the techniques to communicate with input and output devices.
- To study the recent techniques.

Course Outcomes:

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

1. Understand the concepts of microprocessors, their principles and practices.
2. Write efficient programs in assembly language of the 8086 family of microprocessors.
3. Organize a modern computer system and be able to relate it to real examples.
4. Develop the programs in assembly language for 80286, 80386 and MIPS processors in real and protected modes.
5. Implement embedded applications using ATOM processor.
6. Analysis the real time application of it.

UNIT I: 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.

UNIT II: Memory organization

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

UNIT III: 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.

Module IV: 16 and 32 microprocessors

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

Module V: Pipelining

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.

SUGGESTED READINGS

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.
3. J. L. Hennessy and D. A. Patterson, **"**Computer Architecture A Quantitative Approach**"**, Morgan Kauffman, 2011.
4. W. Stallings, **"**Computer organization**"**, PHI, 1987.

Semester – VI

21PBEEE6E05 INTRODUCTION TO NEURAL NETWORKS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To introduce the basic concepts of neural networks and its applications in various domain
- To educate how to use Soft Computing to solve real-world problems
- To have a solid understanding of Basic Neural Network.
- To provide students with a sound and comprehensive understanding of artificial neural networks and machine learning.
- To gain exposure in the field of neural networks and relate the human neural system into the digital world
- To provide knowledge of computation and dynamical systems using neural networks

Course Outcomes

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

- Understand the basic concepts of neural networks and its applications in various domains
- Gain knowledge about learning process in Neural Networks
- Apply perception concept in design
- Design using Hopfield Network
- Gain knowledge on SOM concepts
- Ability to develop the use of Soft Computing to solve real-world problems

UNIT I INTRODUCTION TO NEURAL NETWORKS

Biological Neuron, artificial neuron-comparison, neuron model, architectures-Feedforward and recurrent types. Perceptron -learning rule-graphical, algorithmn, limitations, multilayer network.

UNIT II BACKPROPAGATION NETWORKS

Backpropagation algorithm-derivation of up-dation rules, drawbacks. Variants of Backpropagation algorithm-momentum, variable learning rate-simple problems. Data based modeling using backpropagation algotihm – applications - example.

UNIT III ASSOCIATIVE AND SELF-ORGANIZING NETWORKS

Associative Learning –supervised and unsupervised types- Instar , outstar and Kohonen networks, Bidirectional associative memories, Hopfield Network. Self organizing map algorithm –Simple problems.

UNIT IV SUPERVISED AND UNSUPERVISED LEARNING NETWORKS

Supervised Learning Neural Networks – Radial Basis Function Networks - Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures – Advances in Neural networks.

UNIT V APPLICATIONS

Applications – electric drives- speed control of induction motors

SUGGESTED READINGS

1. Martin T.Hagan,Howard B. Demuth, Mark Beale Neural Network Design Cenage Learning 2008

2.S.N Sivanandam, S.Sumathi, S.N.Deepa Introduction to Neural Networks using MATLAB 6.0 , TMH, 2006

3. Laurene V. Fausett, Fundamentals of Neural Networks-architecture, algorithm and application Pearson Education

Semester – VI

21PBEEE6E06 BIOMEDICAL INSTRUMENTATION 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives:

- The course is designed to make the student acquire an adequate knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance
- To study about instruments for physiological measurements
- To study about devices of non–electrical devices.
- To study about modern methods of imaging techniques.
- To study about nervous system
- To study about medical assistance / techniques and therapeutic equipment.

Course Outcomes:

At the end of the course the student will be to

- Acquaintance of the physiology of the heart, lung, blood circulation and circulation respiration. Methods of different transducers used.
- Understand the student to the various sensing and measurement devices of electrical origin.
- Analysis the latest ideas on devices of non–electrical devices.
- Analysis the important and modern methods of imaging techniques.
- Analysis latest knowledge of medical assistance / techniques and therapeutic equipment.
- Analysis the real time application of it

UNIT I PHYSIOLOGY AND TRANSDUCERS

Cell and its structure – Action and resting potential – Potential propagation of action potential – Sodium pump – Nervous system – CNS – PNS – Nerve cell – Synapse – Cardio pulmonary system – Physiology of heart and lungs – Circulation and respiration – Transducers – Different types – Piezo electric, ultrasonic, resistive, capacitive and inductive transducers – Selection criteria.

UNIT II ELECTRO – PHYSIOLOGICAL MEASUREMENTS

Basic components of a biomedical system – Electrodes – Micro, needle and surface electrodes – Amplifiers – differential, chopper, Isolation and Pre-amplifiers. ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms.

UNIT III NON–ELECTRICAL PARAMETER MEASUREMENTS

Measurement of blood pressure – Cardiac output – Cardiac rate – Heart sound – Respiratory rate – Gas volume – Flow rate of CO_2, O_2 in exhaust air – pH of blood, ESR and GSR measurements – Plethysmography.

UNIT IV MEDICAL IMAGING AND PATIENT MONITORING SYSTEM

X–ray machine – Radiographic and fluoroscopic techniques – Computer Tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems and patient monitoring – Electrical safety.

UNIT V ASSISTING AND THERAPEUTIC EQUIPMENT

Pacemakers – Defibrillators – Ventillators – Nerve and muscle stimulators – Diathermy – Heart-Lung machine – Audio meters – Dializers

SUGGESTED READINGS

1. Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer, Bio–Medical Instrumentation and Measurements Pearson Education, India2002
2. Khandpur, R. S, Handbook of Bio–Medical Instrumentation, Tata McGraw Hill Publishing Co. Ltd., India, 2003
3. Webster, J Medical Instrumentation, John Wiley and Sons, New York, 1995

Semester – VI

21PBEEE6E07 SENSORS AND TRANSDUCERS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- It deals with various types of Sensors & Transducers and their working principle
- It deals with resistive transducers
- It deals with capative transducers
- It deals with inductive transducers
- It deals with some of the miscellaneous transducers
- It deals with characteristics of transducers

Course Outcomes (COs)

At the end of the course the student will be able to
1. understand all types of sensors and transducers.
2. Justify the concept and working principle of different transducers and sensors
3 Justify the transducers that will be utilised in the electrical industries
4. Identify recent developments in transducer domain
5. Discover the knowledge for small technology up gradations in it
6. Analysis the real time application.

UNIT I INTRODUCTION OF TRANSDUCERS

Transducer – Classification of transducers – Basic requirement of transducers.

UNIT II CHARACTERISTICS OF TRANSDUCERS

Static characteristics – Dynamic characteristics – Mathematical model of transducer – Zero, first order and second order transducers – Response to impulse, step, ramp and sinusoidal inputs.

UNIT III RESISTIVE TRANSDUCERS

Potentiometer –Loading effect – Strain gauge – Theory, types, temperature compensation – Applications – Torque measurement – Proving Ring – Load Cell – Resistance thermometer – Thermistors materials – Constructions, Characteristics – Hot wire anemometer.

UNIT IV INDUCTIVE AND CAPACITIVE TRANSDUCER

Self inductive transducer – Mutual inductive transducers– LVDT Accelerometer – RVDT – Synchros – Microsyn – Capacitive transducer – Variable Area Type – Variable Air Gap type – Variable Permittivity type – Capacitor microphone.

UNIT V MISCELLEANEOUS TRANSDUCERS

Piezoelectric transducer – Hall Effect transducers – Smart sensors – Fiber optic sensors – Film sensors – MEMS – Nano sensors, Digital transducers.

SUGGESTED READINGS

1. Sawhney A.K, A Course in Electrical and Electronics Measurements and Instrumentation, 18th Edition, Dhanpat Rai & Company Private Limited,2007
2. Renganathan. S, Transducer Engineering, Allied Publishers, Chennai,2003.
3. Doebelin. E.A, Measurement Systems – Applications and Design, Tata McGraw Hill, New York,2000
4. Patranabis. D Sensors and Transducers PHI Learning Pvt. Ltd. 2003
5. John. P, Bentley Principles of Measurement Systems III Edition, Pearson Education 2000

Semester – VI

21PBEEE6E08 FLEXIBLE AC TRANSMISSION SYSTEMS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To study the various FACTS controllers and its applications.
- To study the characteristics of ac transmission
- To study the effect of shunt and series reactive compensation.
- To study the controllers of FACTS
- To study the coordination of FACT controlling systems
- To study about the reactive compensation according to the need

Course Outcomes (COs)

- At the end of the course the student will gain knowledge about various FACTS controller and its applications.
- Evaluate the characteristics of ac transmission
- Reproduce the effect of shunt and series reactive compensation.
- Justify the working principles of FACTS devices and their operating characteristics
- Getting knowledge in FACTS controller and its coordination
- Real time application studied about FACTS

. **UNIT I INTRODUCTION TO FACTS**

Reactive power control in electrical power transmission lines - series compensation - Concepts of SVC, TCSC and UPFC.

UNIT II SVC AND ITS APPLICATIONS

Objective of shunt compensation – Principle and operating characteristics of Thyristor Controlled Reactor(TCR) – Thyristor Switched Capacitor(TSC)-Voltage control by SVC – Advantages of slope in dynamic characteristics – Applications: Enhancement of transient stability – steady state power transfer – Enhancement of power system damping – prevention of voltage instability.

UNIT III TCSC AND ITS APPLICATIONS

Series compensation and it objectives-Operation of the TCSC – Different modes of operation Application: Improvement of the system stability limit -Enhancement of system damping –Voltage collapse prevention

UNIT IV EMERGING FACTS CONTROLLERS

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics – Unified Power Flow Controller (UPFC) – Principle of operation – Modes of Operation-Applications – Modeling of UPFC for Power Flow – Studies.

UNIT V COORDINATION OF DIFFERENT FACTS CONTROLLERS

Controller interactions – SVC – SVC interaction – Co-ordination of multiple controllers using linear control techniques – Control coordination using genetic algorithms

SUGGESTED READINGS

1. Mohan Mathur R., Rajiv.K.Varma, Thyristor–Based Facts Controllers for Electrical Transmission Systems, IEEE press and John Wiley & Sons, Inc, New York, 2002

2. Narain G. Hingorani, Laszio. Gyugyl, Understanding FACTS : Concepts and Technology of Flexible AC Transmission Systems, Standards publishers, New Delhi, 2001

Semester – VI

21PBEEE6E09 PROFESSIONAL ETHICS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objective

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.
- To study ethics in society and realize the responsibilities and rights in the society
- To study advanced philosophical knowledge of the profession of recreation and leisure
- To study synthesis of trends and issues as related to current professional practice
- To evaluation of organizational theories and human resource management principles
- To study the ethical practice and ethical management

Course Outcome

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

1. Apply ethics in society and realize the responsibilities and rights in the society
2. Discuss the ethical issues related to engineering
3. Advanced philosophical knowledge of the profession of recreation and leisure
4. Synthesis of trends and issues as related to current professional practice
5. Evaluation of organizational theories and human resource management principles
6. Ethical practice and ethical management

UNIT I HUMAN VALUES

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II 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 – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT V 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

Suggested Readings

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
   Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
2. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
3. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
5. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001
6. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.
7. World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011

Semester – VI

21PBEEE6E10 MICROPROCESSOR AND MICROCONTROLLER 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objective

- To study the Architecture of 8085 and 8051.
- To study the addressing modes and instruction set of 8085 and 8051.
- To introduce the need and use of Interrupt structure.
- To develop skill in simple program writing.
- To introduce commonly used peripheral/interfacing ICs and Advanced Processors.
- To study the advanced processors

Course Outcomes

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1. At the end of this course, students will demonstrate the ability to Explain about the architecture of 8051 microprocessor, pin configuration, interrupts and the timing diagram of 8085
2. Develop the assembly language program using mnemonics and corresponding machine code based on architecture of 8051 microprocessor
3. Define the 8051 microcontroller with its architecture, pinouts, memory organization, interrupts and compare the programming concepts with 8051
4. Illustrate the interfacing of 8085 with various peripheral devices for transmission, reception and control of data
5. Make use of the data conversion technique such as ADC and DAC and to interface with 8085 processor and 8051 microcontroller
6. Develop the microcontroller assembly language program for various real time applications

UNIT I 8085 PROCESSOR

Architecture – Functional block diagram – Signals – Memory interfacing – I/O ports and data transfer concepts – Timing Diagram – Interrupt structure.

UNIT II INSTRUCTION SETS

Instruction format and addressing modes – Assembly language format – Data transfer, data manipulation and control instructions.

UNIT III PERIPHERAL INTERFACING

Study of Architecture and programming of ICs: 8255 PPI, 8259 PIC, 8251 USART, 8279 Key board / display controller and 8253 Timer/ Counter – Interfacing with 8085 – A/D and D/A converter interfacing**.**

UNIT IV 8051 MICRO CONTROLLER

Architecture – Functional block diagram – Instruction format and addressing modes – Interrupt structure – Timer –I/O ports – Serial communication.

UNIT V ADVANCED PROCESSORS

Architecture of PIC 16C7X MICROCONTROLLER - memory organization – Addressing modes – Instruction set – Introduction to TMSLF2407 DSP controller and ARM Processors.

Suggested Readings

1. Gaonkar, R. S., Microprocessor Architecture, Programming, and Applications with the 8085, Wiley Eastern Ltd., New Delhi., , 2002
2. Muhammad Ali Mazidi and Janice Gilli Mazidi, The 8051 Micro Controller and Embedded Systems, Pearson Education , New Delhi., 2003
3. William Routt, Microprocessor Architecture, Programming and Systems Featuring the 8085, Delmar Cengage Learning, New York, 2006

Semester – VII

21PBEEE7E01 FUZZY LOGIC AND ITS APPLICATIONS 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To introduce the basic concepts of Fuzzy logic and its applications in various domain
- To educate how to use Fuzzy computation to solve real-world problems
- To have a solid understanding of Basic fuzzy models
- To study about the development of fuzzy controllers
- To Understand the concepts of adaptive fuzzy control
- To study the fuzzy based model system

COURSE OUTCOMES

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

1. Understand the basic concepts of Fuzzy logic and its applications in various domain
2. Gain knowledge on theory of Reasoning
3. Develop fuzzy controllers
4. Understand concepts of adaptive fuzzy control
5. Ability to develop how to use Fuzzy computation to solve real- world problems
6. Design fuzzy based model for any application

UNIT I FUZZY SETS AND RELATIONS

Classical sets, fuzzy sets-operation, properties. Fuzzy relations-Equivalence and tolerance relation, Fuzzication- membership function-types, methods.

UNIT II FUZZY INFERENCE SYSTEM

Building Blocks of a Fuzzy system, fuzzication, fuzzy Rule-based Systems. Composition of rules, types of inference, defuzzication methods. Fuzzy control system- examples

UNIT III FUZZIFICZTION AND FUZZY ARITHMETIC

Lambda-cuts for fuzzy sets-lambda cutsfor fuzzy relations- defuzzification methodsExtension principle-functions of fuzzy sets- fuzzy transform-fuzzy numbers-approximate methods of extension-vertex method-DSW algorithm

UNIT IV FUZZY LOGIC AND FUZZY RULE BASED SYSTEMS

Fuzzy logic –approximate reasoning-fuzzy tautologies-contradictions-equivalence-and logical proofs-other forms of implication operation and composition operation-linguistic hedges-rule based systems-fuzzy associative memories-multiobjective decision making – fuzzy bayesian decision method.

UNIT V APPLICATIONS

Single sample identification-multifeature pattern recognition-image processing-simple fuzzy logic controllers-General fuzzy logic controllers-Industrial applications-Fuzzy tool box in Matlab.

SUGGESTED READINGS

1. D .Diankar ,H. Hellendoom and M .Rein frank An Introduction to Fuzzy Control Narosa Publishers India 1896
2. G.J. KlirandT.A. Folger Fuzzy Sets Uncertainty and Information PHI IEEE 1895
3. Timothy J. Ross Fuzzy Logic with Engineering Applications McGraw Hill1897
4. George. J Klir and Bo Yuan Fuzzy Sets and Fuzzy Logic Prentice Hall, USA 1895

Semester – VII

21PBEEE7E02 DIGITAL SIGNAL PROCESSING 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To introduce the concept of analyzing discrete time signals and systems in the time and frequency domain.
- To classify signals and systems and their mathematical representation.
- To analyze the discrete time systems.
- To study various transformation techniques and their computation.
- To study about filters and their design for digital implementation.
- To study about a programmable digital signal processor and quantization effects.

Course Outcomes (COs)

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

1. Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
2. Analyze discrete-time systems using z-transform.
3. Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. Design digital filters for various applications.
5. Apply digital signal processing for the analysis of real-life signals.
6. Analysis the real time application of it

UNIT I DISCRETE REPRESENTATION OF CONTINUOUS SYSTEMS (6)

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

UNIT II DISCRETE SYSTEM ANALYSIS

Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transferfunction. 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 analysis by Jury test. Stability analysis using bilinear transformation. Design ofdigital control system with dead beat response. Practical issues with dead beat response design.

UNIT- III 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.

UNIT IV 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.

UNIT V DISCRETE OUTPUT FEEDBACK CONTROL

Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

SUGGESTED READINGS

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.

Semester – VII

21PBEEE7E03 POWER QUALITY 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To study the production of voltages sags, over voltages and harmonics and methods of control.
- To study various methods of power quality monitoring.
- To understand the concept of power and power factor in single phase and three phase systems supplying non linear loads
- To understand the conventional compensation techniques used for power factor correction and load voltage regulation.
- To understand the active compensation techniques used for power factor correction.
- To understand the active compensation techniques used for load voltage regulation.

Course Outcomes (COs)

At the end of the course the student will be able to

1.Evaluate the characteristics of ac transmission

2.Reproduce the effect of shunt and series reactive compensation.

3.Justify the working principles of FACTS devices and their operating characteristics.

4.Reproduce the basic concepts of power quality.

5.Rewrite the concept of Harmonics

6.Reproduce and justify the working principles of devices to improve power quality.

UNIT I INTRODUCTION TO POWER QUALITY

Terms and definitions: Overloading, under voltage, sustained interruption; sags and swells; waveform distortion, Total Harmonic Distortion (THD), Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT II VOLTAGE SAGS AND INTERRUPTIONS

Sources of sags and interruptions, estimating voltage sag performance, motor starting sags, estimating the sag severity, mitigation of voltage sags, active series compensators, static transfer switches and fast transfer switches.

UNIT III OVER VOLTAGES

Sources of over voltages: Capacitor switching, lightning, ferro resonance; mitigation of voltage swells: Surge arresters, low pass filters, power conditioners – Lightning protection, shielding, line arresters, protection of transformers and cables, computer analysis tools for transients, PSCAD and EMTP.

UNIT IV HARMONICS

Harmonic distortion: Voltage and current distortion, harmonic indices, harmonic sources from commercial and industrial loads, locating harmonic sources; power system response characteristics, resonance, harmonic distortion evaluation, devices for controlling harmonic

distortion, passive filters, active filters, IEEE and IEC standards.

UNIT V POWER QUALITY MONITORING

Monitoring considerations: Power line disturbance analyzer, power quality measurement equipment, harmonic / spectrum analyzer, flicker meters, disturbance analyzer, applications of expert system for power quality monitoring.

SUGGESTED READINGS

1. Roger C Dugan, Mark, F., McGranagham, Surya Santoso, Wayne Beaty, H, Electrical Power Systems Quality, McGraw Hill, New York,, 2003
2. C. Sankaran, Power Quality, CRC Press, Florida, 2002

Semester – VII

21PBEEE7E04 POWER SYSTEM RESTRUCTURE 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To study about key issues in electric utilities restructuring.
- To study about open access same time information systems.
- Gain the knowledge about power system restructure.
- To study about ISO and its types, roles.
- To known about electricity markets
- To study about knowledge of various trades

Course Outcomes (COs)

At the end of the course student will be able to

1. Analysis about electric energy trading, electric pricing.
2. Analysis about open access same time information systems.
3. Gain the knowledge about power system restructure.
4. Analysis the real time application of it
5. Acquiring knowledge of embedded cost and pricing models in various countries
6. Acquiring knowledge of various trades

UNIT I OVERVIEW OF KEY ISSUES IN ELECTRIC UTILITIES RESTRUCTURING

Restructuring Models: PoolCo Model, Bilateral Contracts Model, Hybrid Model - Independent System Operator (ISO): The Role of ISO - Power Exchange(PX):Market Clearing Price(MCP) - Market operations: Day-ahead and Hour-AheadMarkets, Elastic and Inelastic Markets - Market Power - Stranded costs -Transmission Pricing: Contract Path Method, The MW-Mile Method - CongestionPricing: Congestion Pricing Methods, Transmission Rights - Management of Inter-Zonal/Intra Zonal Congestion: Solution procedure, Formulation of Inter-ZonalCongestion Sub problem, Formulation of Intra- Zonal Congestion Sub problem.

UNIT II ELECTRIC UTILITY MARKETS IN THE UNITED STATES

California Markets: ISO, Generation, Power Exchange, Scheduling Cocoordinator,UDCs, Retailers and Customers, Day-ahead and Hour-AheadMarkets, Block forwards Market, Transmission Congestion Contracts(TCCs) – New York Market: Market operations - PJM interconnection - Ercot ISO - New England ISO - Midwest ISO: MISO's Functions, Transmission Management, Transmission System Security, Congestion Management, Ancillary Services Coordination, Maintenance Schedule Coordination - Summary of functions of U.S. ISOs.

UNIT III OASIS - OPEN ACCESS SAME-TIME INFORMATION SYSTEM

FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Implementation of OASIS Phases: Phase 1, Phase 1-A, Phase 2 - Posting of information: Types of information available on OASIS, Information requirement of OASIS, Users of OASIS -

Transfer Capability on OASIS: Definitions, Transfer Capability Issues, ATC Calculation, TTC Calculation, TRM Calculation, CBM Calculation - Transmission Services - Methodologies to Calculate ATC -Experiences with OASIS in some Restructuring Models: PJM OASIS, ERCOT OASIS.

UNIT IV ELECTRIC ENERGY TRADING

Essence of Electric Energy Trading - Energy Trading Framework: The Qualifying factors - Derivative Instruments of Energy Trading: Forward Contracts, Futures Contracts, Options, Swaps, Applications of Derivatives in Electric Energy Trading -Portfolio Management: Effect of Positions on Risk Management - Energy Trading Hubs - Brokers in Electricity Trading - Green Power Trading

UNIT V ELECTRICITY PRICING - VOLATILITY, RISK AND FORECASTING

Electricity Price Volatility: Factors in Volatility, Measuring Volatility – Electricity Price Indexes: Case Study for Volatility of Prices in California, Basis Risk -Challenges to Electricity Pricing: Pricing Models, Reliable Forward Curves -Construction of Forward Price Curves: Time frame for Price Curves, Types of Forward Price Curves – Short-term Price Forecasting: Factors Impacting Electricity Price, Forecasting Methods, Analyzing Forecasting Errors, PracticalData Study.

SUGGESTED READINGS

1. Sawhney A.K, A Course in Electrical and Electronics Measurements and Instrumentation, , 18th Edition, Dhanpat Rai & Company Private Limited,, 2007
2. Renganathan. S, , Transducer Engineering Allied Publishers, Chennai, 2003
3. Mohammad Shahidehpour and MuwaffaqAlmoush, Restructured ElectricalPower Systems Operation, Trading and Volatility,, Marcel Dekkar, Inc, 2001

Semester – VII

21PBEEE7E05 MODERN SEMICONDUCTOR DEVICES 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To study the power semiconductor switches.
- To study about the characteristics and applications of Power diode, power BJT, Thyristor, GTO, IGBT, MOSFET.
- To study the real time application of it.
- To study the basics of thyristor technologies
- To study the new semiconductor material of power devices
- To study the safe operating area of the power devices

Course Outcomes (COs)

1. Understand the concepts of modern semiconductor devices
2. Understand the different characteristics of conductor devices
3. Analysis the real time application of it.
4. To learn deep knowledge of thyristor technologies
5. To study about real time applications of inverters and rectifiers
6. To learn about protection of device circuits

UNIT I OVERVIEW OF POWER SEMICONDUCTOR SWITCHES

Introduction - Diodes, Thyristors, BJTs, JFETs, MOSFETs, GTOs, IGBTs, Comparison of these as switching devices, Drive and Protection circuit for these devices – New Semiconductor materials for Power devices.

UNIT II POWER DIODE AND POWER BJT

Basic structure and I-V & Switching characteristics of Power diode, Schottky diode - Structure and switching characteristics of Power BJT - Breakdown voltage considerations - Safe operating area - Drive circuits for BJT – Snubber design for Power diode.

UNIT III THYRISTORS AND GTOs

Basic structures - I-V characteristics - Physics of device operation - Switching characteristics of Thyristors and GTOs – Derive circuits - Snubber circuits for Thyristors and GTOs - Over current protection of GTO.

UNIT IV IGBT AND POWER JFET & MOSFETS

Basic structures - I-V characteristics, physics of device operation - Switching characteristics – Safe operating area of IGBT and Power JFET & MOSFET - Derive circuits and Protection.

UNIT V APPLICATIONS

Single phase rectifiers and Three phase rectifiers using Diodes and Thyristors, Choppers, Inverters using GTOs-IGBTs and power JFETs & MOSFETs.

SUGGESTED READINGS

1. Mohan. Net al,, Power Electronics: Converters, Applications and Design,, John Wiley and Sons, New York, Third Edition, 2002
2. Rashid M.H, Power Electronics Circuits, Devices and Applications,, Prentice Hall India, Third edition, New Delhi2004

Semester – VII

21PBEEE7E06 **SMART GRID** **3H-3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To study about the characteristics of smart grid, models and operating principles.
- To study about energy storage and communication systems used in smart grid.
- To study the models and operating principles of smart grid
- To study the different batteries technology
- To get knowledge about communication system in smart grid
- To study about reliability and stability process

Course Outcomes (COs)

At the end of the course the student will be able to

1. Gain the knowledge about Distributed Generations.
2. Acquire the knowledge about Island mode of operation**.**
3. Understand the basic knowledge about storage devices
4. Analysis the different batteries technology.
5. Understand the communication system in smart grid
6. Analysis the reliability and stability process

UNIT I INTRODUCTION : SMART GRID AND EMERGING TECHNOLOGIES

Defining a smart grid – Characteristics of smart grid - Values of a smart grid – The economic Case – The environmental Case – Benefits to utilities – Benefits to consumers – Power system components – Power system protection: Traditional Vs Smart – Case study – Generation fundamentals – Traditional Generations – Distributed Generations – micro grid generation – Generator Protection – Challenges and Opportunities – Cost of smart grid – Government Regulations – Emerging Technologies - FACTS – optimizing integration systems – Multi generation buildings – Case study.

UNIT II SMART GRID: MODELS AND OPERATING PRINCIPLES

Solar Photovoltaic models and grid Integration – Design of a 2 MVA PV station – DG system as part of utility power system – The smart grid PV - UPS DG system – Split DC Bus UPS – PV DG system – Island mode of operation – Parallel operation of Inverters – Power Quality. Wind turbine model and grid Integration – Micro turbine model & Grid Integration. Electric Vehicle model and Grid Integration.

UNIT III SMART GRID: DISTRIBUTED GENERATION SYSTEMS

Power Converter System – Control System Development – Current limit and Saturation Control, Simulation using simulate and MATLAB. Inverter Parallel operation – Load sharing control Algorithm – Distributed Generation System and Newton Raphson method in power flow – Plant modeling and 3 phase 4 wire DG unit topology – Single distributed generation System –MIMO Linear system Stability robustness – PWM rectifier control –
3 Phase AC – DC – AC topology.

UNIT IV ENERGY STORAGE AND COMMUNICATION

State–of–the art storage devices – Battery types – Ultra capacitors based Energy Storage System – Flywheel – Wide Area Network – Substation Information System – Wireless Networks – Distribution Automation – AMI Networks – Utility monitoring and Control – Inter-system Coordination – Industrial systems – Consumer Residential Systems – Network Protection – Channel model Fundamental – Low, medium, High voltage, main Topologies – Residential and Business Indoor wiring Topologies – The Power line Channel model – Digital Transmission Techniques - Threats – IEC61850 Considerations.

UNIT V SMART GRID: RELIABILITY, STABILITY AND COMPONENT INTEGRATION

Smart Grid Programming – Virtual Power Producer – Intelligent reconfiguration using SCADA – Problems in distributed grids – Solutions. Integration of Mini – Micro generation in distribution Grids – Power supply Quality generic standards – Renewable Energies specific standards – Smart Grid stability analysis schemes – Supply guarantee and Power quality – Integration in power systems – Distributed Generation advantages and needs.

SUGGESTED READINGS

1. Fox-Penner, Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities, , Island Press Washington DC2010

2. StanMark Kaplan, Fred Sissine, Smart Grid: Modernizing Electric Power Transmission and Distribution; Energy Independence, Storage and Security; Energy Independence and Security Act and Resiliency, The Capitol.Net, Washington DC,, 2009

Semester – VII

21PBEEE7E07 ELECTRIC HYBRID VEHICLE 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To study the basic concepts of electric hybrid vehicles.
- To study about energy storage system for hybrid vehicle.
- To gain the knowledge about electric propulsion unit.
- To gain the concept of Hybrid Electric Drive-Trains.
- To gain the different Energy Management Strategies.
- To study about the efficiency manipulation in drives

Course Outcomes (COs)

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

1.Understand the models to describe hybrid vehicles and their performance.

2. Understand the concept of Electric Trains.

3. Understand the different possible ways of energy storage.

4. Understand the different strategies related to energy storage systems.

5. Understand the different strategies related to energy management systems.

6. Understand the concept of different Motor drive.

UNIT I INTRODUCTION

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT II ELECTRIC TRAINS

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III ELECTRIC PROPULSION UNIT

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives,Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT IV ENERGY STORAGE

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive

system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

UNIT- V ENERGY MANAGEMENT STRATEGIES

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

SUGGESTED READINGS

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
4. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.

Semester – VII

21PBEEE7E08 POWER SYSTEM PROTECTION AND SWITCHGEAR 3H-3C

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To expose the students to the various faults in power system
- To learn the various methods of protection scheme
- To understand the current interruption in Power System and study the various switchgears.
- Discussion on various earthing practices, usage of symmetrical components to estimate fault current and fault MVA.
- Study of Relays, protection scheme, and solid state relays.
- To understand the method of circuit breaking, various arc theories, Arcing phenomena – capacitive and inductive breaking, Types of circuit breakers.

Course Outcomes (COs)

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

1. Understand the different components of a protection system.
2. Evaluate fault current due to different types of fault in a network.
3. Understand the protection schemes for different power system components.
4. Understand the basic principles of digital protection.
5. Understand system protection schemes, and the use of wide-area measurements.
6. Analysis the real time application of its

UNIT I INTRODUCTION

Principles and need for protective schemes – nature and causes of faults –Power system earthing - Zones of protection and essential qualities of protection – Protection scheme**.**

UNIT II OPERATING PRINCIPLES AND RELAY CONSTRUCTIONS

Electromagnetic relays – Over current, directional, distance and differential, under frequency relays – static relays.

UNIT III APPARATUS PROTECTION

Apparatus protection: Transformer, generator, motor; protection of bus bars and transmission lines – CTs and PTs and their applications in protection schemes.

UNIT IV THEORY OF CIRCUIT INTERRUPTION

Physics of arc phenomena and arc interruption. Restriking voltage, Recovery voltage, rate of rise of recovery voltage, resistance switching, current chopping, and interruption of capacitive current – DC circuit breaking.

UNIT V CIRCUIT BREAKERS

Types of Circuit Breakers – Air blast, Air break, oil, SF_6 and Vacuum circuit breakers – comparative merits of different circuit breakers – Testing of circuit breakers.

SUGGESTED READINGS

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