DHANALAKSHMI SRINIVASAN UNIVERSITY
Samayapuram, Trichy – 621 112

SCHOOL OF ENGINEERING AND TECHNOLOGY
B. Tech – Electrical & Electronics Engineering

Curriculum & Syllabus

B. Tech EEE: I - VIII Semesters - Curriculum

Semester I								
S. No	**Subject Code**	**Subject Name**	**Subject Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1	21ENG01	Basics in Communication	HS	3	2	0	1	3
2	21MAT01	Algebra and Calculus	BS	4	3	1	0	4
3	21PHY01/ 21CHY01	Engineering Physics/ Engineering Chemistry	BS	3	3	0	0	3
4	21GEN01	Engineering Graphics & Design	ES	5	1	0	4	3
5	21GEN02	Programming for Problem Solving	ES	3	3	0	0	3
6	21NCP01	Yoga	NC	2	0	0	0	0
Practical								
7	21PHYP1/ 21CHYP1	Engineering Physics/ Chemistry Laboratory	BS	2	0	0	2	1
8	21GENP2	Programming for Problem Solving Laboratory	ES	2	0	0	2	1
			Total	24	12	1	9	18

Semester II								
S. No	**Subject Code**	**Subject Name**	**Subject Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1	21ENG02	Technical Communication	HS	3	2	0	0	2
2	21MAT02	Advanced Calculus and ODE	BS	4	3	1	0	4
3	21PHY01/ 21CHY01	Engineering Physics/ Engineering Chemistry	BS	3	3	0	0	3
4	21GEN04	Basic Civil & Mechanical Engineering	ES	3	3	0	0	3
5	21EEE01	Theory of Electrical Circuits	PC	5	3	1	0	4
6	21NCP02	NSS	NC	3	0	0	0	0

Practical								
7	21PHYP1/ 21CHYP1	Engineering Physics/ Chemistry Laboratory	BS	2	0	0	2	1
8	21GEN05	Workshop Practices	ES	4	0	0	4	2
9	21ENGP2	Communication Skills Laboratory	HS	2	0	0	2	1
			Total	28	14	2	8	20

Semester III								
S. No	**Subject Code**	**Subject Name**	**Subject Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1	21ENG03	Professional Communication	HS	3	2	0	0	2
2	21MAT05	Mathematics III	BS	5	3	1	0	4
3	21EEE02	Electrical Machinery I	PC	5	3	1	0	4
4	21EEE03	Engineering Electromagnetics	PC	4	3	0	0	3
5	21EEE04	Semiconductor Devices & Circuits	PC	4	3	0	0	3
6	21EEE05	Transmission & Distribution	PC	4	3	0	0	3
7	21NCP03	Environmental Science	NC	2	0	0	0	0
Practical								
8	21EEEP1	Electrical Machinery I Lab	PC	4	0	0	3	2
9	21EEEP2	Circuits & Devices Lab	PC	4	0	0	3	2
			Total	35	17	2	6	23

Semester IV								
S. No	**Subject Code**	**Subject Name**	**Subject Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1	21ENG04	Advanced Technical Communucation	HS	3	2	0	0	2
2	21EEE06	Electrical Machinery II	PC	3	3	1	0	4
3	21EEE07	Measurements & Instrumentation	PC	3	3	0	0	3
4	21EEE08	Control Systems	PC	5	3	1	0	4
5	21EEE09	Analog & Digital Circuits	PC	4	3	0	0	3
6	21NCP04	Renewable Energy Sources	NC	2	0	0	0	0
Practical								
7	21EEEP3	Electrical Machinery II Lab	PC	3	0	0	3	2
8	21EEEP4	Control & Instrumentation Lab	PC	3	0	0	3	2
9	21EEEP5	Analog & Digital Circuits Lab	PC	3	0	0	3	2
			Total	33	17	2	9	22

Semester V								
S. No	**Subject Code**	**Subject Name**	**Subject Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1	21EEE10	Power electronics	PC	4	3	0	0	3
2	21EEE11	Power System Analysis	PC	4	3	0	0	3
3	21EEE12	Protection and Switchgear	PC	4	3	0	0	3
4	21EEE13	Microprocessor and Microcontroller	PC	4	3	0	0	3
5	21CSE03	Object Oriented Programming	ES	4	3	0	0	3
6		Professional Elective I	PE	4	3	0	0	3
7	21NCP05	Essence of Indian Traditional Knowledge	NC	2	0	0	0	0
Practical								
8	21EEEP6	Microprocessor and Microcontroller Lab	PC	4	0	0	4	2
9	21CSEP4	Object Oriented Programming Lab	ES	2	0	0	2	1
10	21ENGP3	Professional Communication Lab	HS	2	0	0	2	1
			Total	34	18	0	8	22

Semester VI								
S. No	**Subject Code**	**Subject Name**	**Subject Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1	21EEE14	Solid State Drives	PC	3	3	0	0	3
2	21UHV02	Professional Ethics and Human Values (UHV-II)	HS	3	3	0	0	3
3		Professional Elective - II	PE	3	3	0	0	3
4		Professional Elective - III	PE	3	3	0	0	3
5		Open Elective - I	UOE	3	3	0	0	3
6		Open Elective - II	UOE	3	3	0	0	3
Practical								
7	21EEEP7	Power Electronics & Drives Lab	PC	4	0	0	2	2
8	21EEEIN	Internship / In-plant Training	EEC	2	0	0	0	0
9	21EEEMP	Mini Project	EEC	2	0	0	2	1
			Total	26	18	0	4	21

Semester VII								
S. No	**Subject Code**	**Subject Name**	**Subject Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1	21GEN06	Disaster Management	HS	3	3	0	0	3
2	21EEE15	Power System Operation and Control	PC	4	3	0	0	3
3		Professional Elective – IV	PE	4	3	0	0	3
4		Professional Elective – V	PE	4	3	0	0	3
5		Open Elective –III	UOE	4	3	0	0	3
Practical								
6	21EEEP8	Power System Simulation Lab	PC	4	0	0	2	2
7	21EEETS	Technical Seminar/ Publication	EEC	2	0	0	2	1
			Total	25	15	0	4	18

Semester VIII								
S. No	**Subject Code**	**Subject Name**	**Subject Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1		Open Elective -IV	UOE	3	3	0	0	3
2		Professional Elective - VI	PE	3	3	0	0	3
Project								
3	21EEEPW	Project Work	EEC	20	0	0	0	10
			Total	26	6	0	0	16

B. Tech EEE: II - VIII Semesters – Syllabus

21EEE01	THEORY OF ELECTRICAL CIRCUITS	L	T	P	C
		3	1	0	4

Course Objectives

1. To introduce electric circuits and its analysis
2. To impart knowledge on solving circuit equations using network theorems
3. To introduce the phenomenon of resonance in coupled circuits.
4. To educate on obtaining the transient response of circuits.
5. To introduce Phasor diagrams and analysis of three phase circuits.

Unit 1 - DC Circuit Analysis **12**

Fundamentals concepts of R, L and C elements-Energy Sources- Ohm's Law -Kirchhoff 's Laws Resistors in series and parallel circuits - voltage and current division, source transformation – star delta conversion- Mesh current and node voltage methods of D.C Circuits-Thevenins and Norton Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocityand Millman's theorem.

Unit 2 – AC Circuit Analysis **12**

A.C Circuits – Average and RMS Value – Complex Impedance – Phasor diagram - Real andReactive Power, Power Factor, Energy - Mesh current and node voltage methods of A.C Circuits.

Unit 3 - Three Phase Circuits **12**

Three phase A.C. circuits – Average and RMS value - Phasor Diagram – Power, Power Factor and Energy-Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced – phasor diagram of voltages and currents – power measurementin three phase circuits.

Unit 4 - Transient Response Analysis **12**

L and C elements - Transient response of RL, RC and RLC Circuits using Laplace transform forDC input and A.C. sinusoidal input.

Unit 5 - Resonance and Coupled Circuits **12**

Series and parallel resonance –frequency response – Quality factor and Bandwidth – Self and mutual inductance – Coefficient of coupling – Dot rule-Analysis of coupled circuits– Single Tuned circuits.

Total: 60

Course Outcome

1. Ability to analyse electrical circuits
2. Ability to apply circuit theorems
3. Ability to draw phasor diagrams and analysis of three phase circuits.
4. Ability to analyse transients

Text Books

1. William H. Hayt, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis",McGraw Hill publishers, edition, New Delhi, 2013.
2. Sudhakar A and Shyam Mohan SP, "Circuits and Networks Analysis and Synthesis", McGrawHill, 2015.
3. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai & Sons, New Delhi,2020.

References

1. Charles K. Alexander, Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”, SecondEdition, McGraw Hill, 2013.
2. Allan H. Robbins, Wilhelm C. Miller, “Circuit Analysis Theory and Practice”, CengageLearning India, 2013.
3. Joseph A. Edminister, Mahmood Nahvi, “Electric circuits”, Schaum’s series, McGraw-Hill,First Edition, 2019.
4. Richard C. Dorf and James A. Svoboda, “Introduction to Electric Circuits”, 7th Edition, JohnWiley & Sons, Inc. 2018.

21EEE02	Electrical Machinery I	L	T	P	C
		3	1	0	4

Course Objectives

6. To impart the knowledge on magnetic circuits
7. To understand the constructional details , operation and testing of transformers
8. To impart the knowledge on basics of electromechanical energy conversion
9. To understand the constructional details, operation and characteristics of DC generator
10. To understand the operation of DC motor and analyze the performance of DC machine

Unit 1 – Magnetic Circuits 12

Magnetic circuits - Laws governing magnetic circuits - Flux linkage, Inductance and energy - Statically and Dynamically induced EMF – Torque - Properties of magnetic materials, Hysteresis and Eddy Current losses - AC excitation, introduction to permanent magnets.

Unit 2 - Transformers 12

Construction - Principle of operation - Equivalent circuit parameters - Phasor diagrams, losses – Testing - Efficiency and voltage regulation - All day efficiency - Sumpner‟s test, three phase transformers - Connections - Scott Connection - Phasing of transformer - Parallel operation of three phase transformers - Auto transformer

Unit 3 - Concepts of Electromechanical Energy Conversion in Rotating Machines 12

Energy in magnetic system - Field energy and coenergy - Force and torque equations - Singly and multiply excited magnetic field systems - MMF of distributed windings - Winding Inductances - Concept of rotating magnetic field.

Unit 4 - DC Generators 12

Construction and components of DC Machine – Principle of operation - Lap and wave windings - EMF equations – circuit model – armature reaction –Demagnetizing and Cross magnetizing ampere turns per pole - methods of excitation-commutation and interpoles - compensating winding – characteristics of DC generators - Applications.

Unit 5 - DC Motors 12

Principle and operations - types of DC Motors –Characteristics of DC Motors-starting methods- speed control of DC motors – Plugging, dynamic and regenerative braking-testing and efficiency – Retardation test- Swinburne‟s test and Hopkinson‟s test - applications of DC Motor.

Total: 60

Course Outcome

5. Analyze the magnetic circuits
6. Evaluate the performance of transformers using equivalent circuits
7. Understand the basic concept of electromechanical energy conversion
8. Acquire the knowledge in construction and working of DC generator
9. Select the appropriate DC motor for industrial applications

Text Books

4. Nagrath, I.J. and Kothari, D.P., “Electrical Machines”, Tata McGraw-Hill Education Private Limited Publishing Company Ltd., 5th Edition, 2017.
5. Theraja A.K and Theraja B.L, “A Text book of Electrical Technology (Vol II)”, S Chand & Co., 3rd Edition 2009.

References

5. A.E. Fitzgerald & Charles Kingsley,”Electric Machinery‟, Tata McGraw-Hill Education Publications, 6th Edition, 2015.
6. P. C. Sen., “Principles of Electrical Machines & Power Electronics”, John Wiley & Sons, 7th Edition 2007.
7. M.N.Bandyopadhyay, “Electrical Machines Theory & Practice”, PHI Learning PVT LTD., New Delhi, 2009.
8. Dr. P.S. Bhimbra, “Electrical Machinery”, Khanna Publications, 7th Edition, 2017.
9. Rajput, R.K, “Electrical Machines”, Laxmi publications, New Delhi 5th Edition, 2016.

21EEE03	Engineering Electromagnetics	L	T	P	C
		3	0	0	3

Course Objectives

1. To convey the basic physical concepts that lie behind all electrical engineering, the interactions between charged particles, whether stationary or in motion.
2. To examine the electric and magnetic forces between stationary and steadily moving charged particles.
3. To study the various electric & magnetic field concepts both in static and time varying condition.

Unit 1 – Electrostatics **12**

Different Co-ordinate Systems: Cartesian, Cylindrical and Spherical –Differential elements in different coordinate systems – Del Operator: Divergence, Curl and Gradient, Divergence Theorem – Stoke’s Theorem - Helmholtz’s Decomposition - Coulomb’s law – Electric Field Intensity – Electric Flux – Gauss’s Law – Potential due to Point, Line and Surface Charge Distributions.

Unit 2 - Electric Fields in Dielectrics and Conductors **12**

Different current flow mechanisms – Continuity equation and relaxation time - Boundary conditions – Laplace and Poisson’s equations - Solutions – Analytical Methods – Variables separable methods – Method of images – Numerical Techniques - Finite Difference Method – Electrostatic Energy – Capacitance Calculations.

Unit 3 - Magnetostatics **12**

Magnetic Circuit-Magnetic field intensity (H) – Biot Savart’s Law – Ampere’s Circuit Law – H due to straight conductors, circular loop, infinite sheet of current,– Lorentz force, Torque, scalar and vector potential, magnetic materials – Magnetization, Boundary conditions, Inductance, Energy density, Applications.

Unit 4 - Electrodynamic Fields **12**

Faraday‟s law – Transformer and motional EMF – Displacement current –Maxwell‟s equations (differential and integral form) – Relation between field theory and circuit theory– Applications.

Unit 5 - Electromagnetic Waves **12**

Electromagnetic wave equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth – Electromagnetic power flow and Pointing vector. Wave Propagation in Transmission lines.

Total: 60

Course Outcome

1. Understand the basic mathematical concepts related to electromagnetic vector fields.
2. Apply Coulomb's Law and Gauss Law to compute electric potential and electric flux density.
3. Apply Biot-savart Law and Ampere's Law to find Magnetic potential.
4. Analyze static and dynamic electromagnetic fields.
5. Analyze the parameters of electromagnetic wave propagation in different medium.

Text Books

1. Mathew N. O. Sadiku, ‘Principles of Electromagnetics’, 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, ‘Engineering Electromagnetics’, McGraw Hill Special Indian edition, 2014.

References

1. Willia Hart Hayt, John A. Buck, ‘Engineering Electromagnetics’, McGraw-Hill, Eighth Edition, 2012.
2. Josep A. Edminister, ‘Schaum's Outline of Electromagnetics’, McGraw-Hill Professional, Fourth Edition, 2013.
3. Karl E. Lonngren, Sava Savov, Randy J. Jost, ‘Fundamental of Electomagnetic with MATLAB’, 2007.

21EEE04	Semiconductor Devices & Circuits	L	T	P	C
		3	0	0	3

Course Objectives

1. To apply the knowledge of solid state devices principles to analyze electronic circuits.
2. To design amplifiers under different configurations and study their responses
3. To learn the required functionality of positive and negative feedback systems.

Unit 1 – PN Junction Devices and Applications **9**

PN junction diode –structure, operation and V-I characteristics, diffusion and transient capacitance, Diode based Clipper and Clamper, Rectifiers – Half Wave and Full Wave Rectifier – LED, Laser diodes - Zener diode characteristics - Zener Reverse characteristics – Zener as regulator.

Unit 2 - Transistors **9**

BJT - CE, CB & CC Configuration - JFET, MOSFET- structure, operation, characteristics, Fixed and voltage divider biasing, Thyristor, UJT and IGBT Structure and characteristics.

Unit 3 - Amplifiers **9**

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

Unit 4 - Multistage Amplifiers And Differential Amplifier **9**

Cascade amplifier, Differential amplifier – Common mode and Difference mode analysis –Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types.

Unit 5 - Feedback Amplifiers and Oscillators **9**

Advantages of negative feedback – voltage / current, series, Shunt feedback – Positive feedback – Condition for oscillations, phase shift – Wien Bridge, Hartley, Colpitts and Crystal oscillators.

Total: 45

Course Outcome

1. Understand the behaviour and analyse the characteristics of semiconductor devices.
2. Infer the various configurations of BJT, MOSFET.
3. Analyze the high speed response of semiconducting devices.
4. Compare and contrast the negative and positive feedback in amplifiers.

Text Books

1. David A. Bell,"Electronic devices and circuits", Oxford University higher education, 5th edition 2008.
2. Sedra and smith, "Microelectronic circuits", 7th Ed., Oxford University Press.

References

1. D.A. Neamen, Electronic Circuits – Analysis and Design, 3Ed, McGraw Hill, 2011.
2. David A. Bell, "Electronic Devices and Circuits", 5ed, Oxford University Press, 2008.
3. Behzad Razavi, Fundamentals of Microelectronics, 3Ed, Wiley, 2013.
4. Ben Streetman, Sanjay Banerjee, Solid State Electronic Devices, 7ED, Pearson, 2014.

21EEEP1	Electrical Machinery I Lab	L	T	P	C
		0	0	4	2

Course Objectives

1. To conduct testing and experimental procedure on different types of electrical machines.
2. To analyse the operation of machines under different loading conditions.

List of Experiments

1. Open circuit and load characteristics of DC separately excited shunt generator
2. Open circuit and load characteristics of DC self-excited shunt generator
3. Load characteristics of differential DC compound generator
4. Load characteristics of DC shunt motor
5. Load characteristics of DC series motor
6. Speed control of DC shunt motor
7. Swinburne's test
8. Load test on single-phase transformer
9. Load test on three phase transformer
10. Open circuit and short circuit tests on single phase transformer
11. Sumpner's test on transformers
12. Separation of no-load losses in single phase transformer
13. Parallel operation of single phase transformers.
14. Performance characteristics of DC series motor using MATLAB/SIMULINK.
15. Speed control of DC shunt motor using MATLAB/SIMULINK.

Total: 60

Course Outcome

1. Ability to understand and analyze DC Generators.
2. Capability to understand and analyze DC Motors.
3. Ability to understand and analyse Transformers.

21EEEP2	Circuits & Devices Lab	L	T	P	C
		0	0	4	2

Course Objectives

1. To understand the working of RL,RC and RLC circuits
2. To gain hand on experience in theorems, KVL & KCL.
3. To learn the characteristics of basic electronic devices such as Diode, BJT,FET, SCR.

List of Experiments

1. Verifications of Thevinin's & Norton's theorem.
2. Verifications of KVL & KCL.
3. Verifications of Super Position Theorem using MATLAB
4. Verifications of maximum power transfer & reciprocity theorem using MATLAB
5. Determination of Resonance Frequency of Series & Parallel RLC Circuits Using MATLAB
6. Transient analysis of RL and RC circuits using MATLAB
7. Characteristics of PN Junction Diode.
8. Zener diode Characteristics & Regulator using Zener diode.
9. Common Emitter input-output Characteristics.
10. Common Base input-output Characteristics.
11. FET Characteristics.
12. SCR Characteristics.
13. Clipper , Clamper & FWR using MATLAB

Total: 60

Course Outcome

1. Verify theorems KVL & KCL.
2. Design RL and RC circuits.
3. Able to analyze the characteristics of basic electronic devices.

21EEE05	Transmission & Distribution	L	T	P	C
		3	0	0	3

Course Objectives

1. To develop basic knowledge in Electrical Transmission and Distribution
2. To learn the substation operation and maintenance of Substations

Unit 1 – Basics of Transmission and Distribution **9**

Structure of electric power system – types of transmission systems – AC systems, DC systems – requirements of good distribution system – types of distribution system – Extra High Voltage AC (EHVAC) Transmission – need, advantages, limitations – High Voltage Direct Current Transmission (HVDC) – classifications, advantages, limitations – comparison of EHVAC and HVDC transmission – Introduction to Flexible AC Transmission System (FACTS).

Unit 2 - Transmission Line Parameters **9**

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 – application of self and mutual GMD – skin and proximity effect – interference with neighbouring communication circuits.

Unit 3 - Modelling and Performance of Transmission Lines **9**

Performance of Transmission lines - short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance -transmission efficiency and voltage regulation, real and reactive power flow in lines – Power Circle diagrams - Formation of Corona – Critical Voltages – Effect on Line Performance.

Unit 4 - Insulators and Cables **9**

Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators. Cables - Types of Cables – Construction of single core and 3 core Cables - Insulation Resistance – Potential Gradient - Capacitance of Single-core and 3 core Cables - Grading of Cables.

Unit 5 - Mechanical Design of Lines and Distribution System **9**

Mechanical design of OH lines – Line Supports –Types of towers – Stress and Sag Calculation – Effects of Wind and Ice loading Distribution Systems – General Aspects – Kelvin‟s Law – AC and DC distributions - Distribution Loss –Types of Substations -Methods of Grounding – Trends in Transmission and Distribution: EHVAC,HVDC and FACTS (Qualitative treatment only).

Total: 45

Course Outcome

1. To understand the various transmission and distribution systems.
2. To develop the mathematical model of different types of transmission system
3. To determine the performance of transmission lines under various conditions
4. To understand the role of insulators and its characteristics.
5. To know the functioning of substations and to evaluate the performance of distribution systems.

Text Books

1. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2011.
2. C.L.Wadhwa, 'Electrical Power Systems', New Academic Science Ltd, 2009.

References

1. Luces M.Fualken berry, Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 2007.
2. Arun Ingole, "power transmission and distribution" Pearson Education, 2017
3. J.Brian, Hardy and Colin R.Bayliss 'Transmission and Distribution in Electrical Engineering', Newnes; Fourth Edition, 2012.
4. G.Ramamurthy, "Handbook of Electrical power Distribution," Universities Press, 2013.

21EEE06	Electrical Machinery II	L	T	P	C
		3	1	0	4

Course Objectives

1. To learn the operation of synchronous machines and their characteristics.
2. To learn the use of equivalent circuit and circle diagram for Induction motor.
3. To learn the performance of special machines and their applications.

Unit 1 – Synchronous Generator 12

Construction - Working principle - EMF equation - Armature windings – Synchronous reactance - Armature reaction – Voltage regulation - EMF, MMF, ZPF, ASA methods - Synchronizing to infinite bus bars - Operating characteristics - Capability curves - Two reaction theory - Parallel operation of synchronous generators.

Unit 2 - Synchronous Motor 12

Principle of operation - Methods of starting - Power developed by a synchronous motor - Synchronous motor with different excitations - Effect of increased load with constant excitation - Effect of changing excitation constant load - Torque equation – V curve and inverted V curve - Hunting – Synchronous phase modifier - PF correction.

Unit 3 - Three Phase Induction Motor 12

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling- Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses – Double cage induction motors –Induction generators – Synchronous induction motor.

Unit 4 - Starting and Speed Control of Induction Motor 12

Need for starter - Types of starters - Starting methods of three phase induction motor - Cogging & crawling - Speed control of three phase induction motor - Double cage rotor.

Unit 5 - Single Phase Induction Motors And Special Machines 12

Single phase induction motor: Construction - Double field revolving theory – Split phase induction motor - Capacitor start induction run motor - Capacitor start capacitor run motor - Equivalent circuit (without and with core loss) - Shaded pole induction motor-Special machines: Universal motor - Stepper motor - Linear induction motor - Reluctance motor - Repulsion motor - hysteresis motor - AC series motor.

Total: 60

Course Outcome

1. Ability to understand the construction and working principle of Synchronous Generator
2. Ability to understand MMF curves and armature windings.
3. Ability to acquire knowledge on Synchronous motor.
4. Ability to understand the construction and working principle of Three phase Induction Motor
5. Ability to understand the construction and working principle of Special Machines.

Text Books

1. D. P. Kothari And I. J. Nagrath, Electric Machines, Tata McGraw Hill Education Pvt. Ltd., New Delhi,: 4thEdition, 2010.

References

1. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, 2003.
2. M.N. Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2009.
3. B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers, 3rd Edition, and Reprint 2015.
4. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, 2002.
5. Alexander S. Langsdorf, 'Theory of Alternating-Current Machinery', McGraw Hill Publications, 2001.

21EEE07	Measurements & Instrumentation	L	T	P	C
		3	0	0	3

Course Objectives

1. To provide basic understanding of electrical and electronic measurement systems.
2. To give a thorough knowledge of varieties of measuring instruments, its operating principles, and limitations.
3. To provide basic understanding of data acquisition systems and virtual instrumentation.

Unit 1 – Introduction **9**

Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Types of instruments - Standards and calibration.

Unit 2 - Electrical Instruments **9**

PMMC Instruments – MI Instruments – Single and three phase watt meters – Single phase induction type energy meters – Instrument transformers – Instruments for measurement of frequency and phase.

Unit 3 - Electronic Instruments **9**

Principle and types of analog and digital voltmeters, ammeters - Principle and types of multi meters – Function generator - General purpose oscilloscope – sampling oscilloscope – digital oscilloscope – Applications.

Unit 4 - DC and AC Bridges **9**

Design of deflection bridges – Wheatstone bridge, Kelvin bridge, Kelvin double bridge and their merits and demerits, AC bridges - Maxwell bridge, Anderson bridge, Schering Bridge, Wien Bridge and their Merits and Demerits.

Unit 5 - Transducers **9**

Classification of transducers – Selection of transducers – Resistive, capacitive & inductive Transducers, Temperature measurement – Piezoelectric, Hall effect, optical and digital transducers, Speed measurement using Contact and non-contact type Tacho generators – Elements of data acquisition system – Smart sensors.

Total: 45

Course Outcome

1. To know the concepts of Fundamentals of electrical and electronic instruments
2. Ability to compare between various measurement techniques
3. To acquire knowledge on various bridges for measuring resistance, inductance and capacitance.
4. To realize the concepts various transducers and the data acquisition systems.
5. Ability to model and analyze electrical and electronic Instruments

Text Books

1. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2010.
2. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons, Delhi, 2013

References

1. H.S. Kalsi, „Electronic Instrumentation‟, McGraw Hill, III Edition 2010.
2. D.V.S. Murthy, „Transducers and Instrumentation‟, Prentice Hall of India Pvt Ltd, 2015
3. David Bell, Electronic Instrumentation & Measurements, Oxford University Press, 2013.
4. Alan. S. Morris, Principles of Measurements and Instrumentation, 2nd Edition, Prentice Hall of India, 2003.
5. Doebelin E.O. and Manik D.N., Measurement Systems – Applications and Design, Special Indian Edition, McGraw Hill Education Pvt. Ltd., 2007.

21EEE08	Control Systems	L	T	P	C
		3	1	0	4

Course Objectives

1. To present a clear exposition of the classical methods of control engineering, physical system modelling, and basic principles of frequency and time domain design techniques.
2. To teach the practical control system design with realistic system specifications.
3. To provide knowledge of state variable models and fundamental notions of state feedback design.

Unit 1 – Systems and their Representations — 12

Basic elements in control systems - open loop & closed loop - Transfer functions of mechanical, electrical and analogous systems - Block diagram reduction - signal flow graphs.

Unit 2 - Time Response Analysis — 12

Time response - step response of first order and second order systems - time domain specification - type and order of a system - steady state error - static error and generalized error coefficient – concepts of stability - Routh Hurwitz stability - P, PI and PID controllers

Unit 3 - Frequency Response Analysis — 12

Frequency domain specifications of second order systems - analysis and stability using Bode plots, Polar plot, Nichols chart - Nyquist stability criterion.

Unit 4 – Root Locus and Compensator Design — 12

Root locus concept - rules for constructing root loci - root contours - design of lag, lead and lag lead compensators using Bode plots

Unit 5 - State Space Analysis — 12

Concepts of state - state variable and state models - state equation - state transition matrix - Transfer function from State Variable Representation- solution of state equation by classical and Laplace transformation method - Concepts of Controllability and Observability.

Total: 60

Course Outcome

1. Formulate mathematical model and transfer function of the physical systems
2. Analyze the system performance by applying various input signals
3. Determine the stability of linear systems in time domain
4. Perform frequency domain analysis using bode and polar plot
5. Analyze the stability of linear system in the frequency domain
6. Design compensators and controllers for the given specifications
7. Formulate and design state-space analysis

Text Books

1. Norman S. Nise, “Control System Engineering”, John Wiley & Sons, 6th Edition, 2011.
2. Benjamin C Kuo “Automatic Control System” John Wiley & Sons, 8th Edition, 2007.

References

1. K. Ogata, “Modern Control Engineering”, Pearson, 5th Edition, 2010.
2. R.C. Dorf & R.H. Bishop, “Modern Control Systems”, Pearson Education, 11th Edition, 2008.
3. M. Gopal, “Control Systems-Principles And Design”, Tata McGraw Hill –4th Edition, 2012.
4. Graham C. Goodwin, Stefan F. Graebe, Mario E. Sagado, “Control System Design”, Prentice Hall, 2003.
5. J.Nagrath and M.Gopal,” Control System Engineering”, New Age International Publishers, 4th Edition, 2006.

21EEE09	Analog & Digital Circuits	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce the functional building blocks, characteristics and applications of Analog ICs
2. To understand different methods for design and implementation of Digital circuits
3. To introduce the various applications of digital and analog ICs

Unit 1 – Operational Amplifier **9**

Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Linear applications of op-amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-V/I & I/V converters; Non- linear applications of op-amp - comparator, Multivibrators, waveform generators and peak detector.

Unit 2 – Special IC's and their Applications **9**

555 Timer and its applications, monostable multivibrator, Astable multivibrator - Linear voltage regulator, 78XX and 79XX family, 723 IC voltage regulator, Switching regulators.

Unit 3 - Digital Techniques **9**

Number systems - Binary, octal and hexadecimal numbers - Binary codes, Logic Gates, Boolean algebra - Conversion and operations. De Morgan's laws, Truth tables, Karnaugh's map and Quine Mccluskey method.

Unit 4 - Combinational Logic Design **9**

Digital Logic families - Logic gates - implementation of combinational logic functions - encoders & decoders - multiplexers & demultiplexers - code converters – comparator - half adder, full adder - parallel adder - binary adder - parity generator/checker - implementation of logical functions using multiplexers.

Unit 5 - Sequential Circuits **9**

Flip flops - SR, D, JK and T - analysis and design of synchronous sequential circuits - state diagram, state reduction and state assignment - counters - modulus counters, shift register, Johnson counter , ring counter – Design of Asynchronous sequential circuits.

Total: 45

Course Outcome

1. Analyze the performance characteristics of Op Amp.
2. Design Op Amp based circuits for engineering applications.
3. Design a basic logic circuit for arithmetic operations in computers.
4. Design complex digital circuits for real time applications.
5. Apply analog/digital ICs for industrial control applications.

Text Books

1. Ramakant Gayakwad, "Op-Amps & Linear Integrated Circuits", Prentice Hall of India, New Delhi, 4th edition, 2002.
2. M. Morris Mano and Mictael Ciletti, "Digital Design", Pearson Education, 5th Edition, 2013.

References

1. Robert F. Coughlin and Frederick F. Driscoll, "Operation Amplifiers & Linear Integrated Circuits", Prentice Hall of India, New Delhi, 6th Edition, 2009.
2. Sergio Franco, "Design with Operational Amplifiers & Analog Integrated Circuits", Tata McGraw Hill Education, 4rd Edition, 2015.
3. Floyd, "Digital Fundamentals", Madrid Pearson Education, 11th Edition, 2016.
4. Albert Malvino, David.J.Bates, "Electronic Principles" Tata Mcgraw Hill Education, 8th Edition, 2016.

21EEEP3	Electrical Machinery II Lab	L	T	P	C
		0	0	4	2

Course Objectives

1. To conduct testing and experimental procedure on different types of electrical machines.
2. To expose the students to the operation of synchronous machines and induction motors and give them experimental skill

List of Experiments

1. Regulation of three phase alternator using EMF method.
2. Regulation of three phase alternator using MMF method.
3. Regulation of three phase alternator using ZPF method.
4. Regulation of three phase alternator using ASA method.
5. Load test on alternator.
6. Parallel operation of two alternators.
7. V and inverted V curves of three phase synchronous motor.
8. Load test on three-phase squirrel cage induction motor.
9. Equivalent circuit for three phase induction motor.
10. Circle diagram for three phase induction motor.
11. Load test on three phase slip ring induction motor
12. Load test on single-phase induction motor.
13. Load test on three phase induction generators.

Total: 60

Course Outcome

1. Ability to understand and analyze EMF and MMF methods
2. Ability to analyze the characteristics of V and Inverted V curves
3. Ability to understand the importance of Synchronous machines
4. Ability to understand the importance of Induction Machines
5. Ability to acquire knowledge on separation of losses

21EEEP4	Control & Instrumentation Lab	L	T	P	C
		0	0	4	2

Course Objectives

1. To provide knowledge on analysis and design of control system along with basics of instrumentation.

List of Experiments

Control Systems

1. AC and DC Position control systems.
2. Design of P, PI and PID controllers.
3. Design of Lag, Lead and Lag-Lead Compensators.
4. Simulation of Stability Analysis (Bode Plot, Root Locus, Nyquist Plot) of a Linear Time Invariant System.
5. Determination of transfer function parameters of an AC and DC servomotor
6. Digital simulation of first and second order systems

Instrumentation

7. AC & DC bridges.
8. Dynamics of Sensors/Transducers

(a) Temperature (b) Pressure (c) Displacement (d) Optical (e) Strain (f) Flow

9. Measurement of power and energy by using an energy meter.
10. Signal Conditioning

(a) Instrumentation Amplifier (b) Analog – Digital and Digital –Analog converters (ADC and DACs)

Total: 60

Course Outcome

1. Ability to understand control theory and apply them to electrical engineering problems.
2. Ability to design controllers and compensators.
3. Ability to understand the basic concepts of bridge networks.
4. Ability to the basics of signal conditioning circuits.
5. Ability to study the simulation packages.

21EEEP5	Analog & Digital Circuits Lab	L	T	P	C
		0	0	4	2

Course Objectives

1. To learn design, testing and characterizing of circuit behaviour with digital and analog ICs.

List of Experiments

1. Design and implementation of inverting and non-inverting amplifier
2. Design and implementation of low pass and high pass filter
3. Design and implementation of integrator and differentiator using op-amp
4. Design and implementation of triangular wave generator using op-amp
5. Design and implementation of summing and difference amplifier
6. Design and implementation of astable multivibrator
7. Design and implementation of half and full adder circuit
8. Design and implementation of multiplexer
9. Design and implementation of magnitude comparator
10. Design and implementation of BCD to 7 segment display
11. Design and implementation of code converters
12. Design and implementation of J,K and D flip flops
13. Design and implementation of shift registers
14. Design and implementation of synchronous decade counter

Total: 60

Course Outcome

1. Ability to understand and implement Boolean Functions.
2. Ability to understand the importance of code conversion
3. Ability to Design and implement 4-bit shift registers
4. Ability to acquire knowledge on Application of Op-Amp
5. Ability to Design and implement counters using specific counter IC

21EEE10	Power Electronics	L	T	P	C
		3	0	0	3

Course Objectives

a. Different types of power semiconductor devices and their switching
b. Operation, characteristics and performance parameters of controlled rectifiers
c. Operation, switching techniques and basics topologies of DC-DC switching regulators.
d. Different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
e. Operation of AC voltage controller and various configurations.

Unit 1 – Power Semi-Conductor Devices 9

Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT- Static characteristics: SCR, MOSFET and IGBT - Triggering and commutation circuit for SCR- Introduction to Driver and snubber circuits.

Unit 2 - Phase-Controlled Converters 9

2-pulse, 3-pulse and 6-pulseconverters– performance parameters –Effect of source inductance–– Firing Schemes for converter–Dual converters, Applications-light dimmer, Excitation system, Solar PV systems.

Unit 3 – Chopper and its Applications 9

Step-down and step-up chopper-control strategy– Introduction to types of choppers-A, B, C, D and E -Switched mode regulators- Buck, Boost, Buck- Boost regulator, Introduction to Resonant Converters, Applications-Battery operated vehicles.

Unit 4 – Inverters 9

Single phase and three phase voltage source inverters (both120^0 mode and 180^0 mode)– Voltage& harmonic control--PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM – Introduction to space vector modulation –Current source inverter, Applications-Induction heating, UPS.

Unit 5 - AC to AC Converters 9

Single phase and Three phase AC voltage controllers–Control strategy- Power Factor Control – Multistage sequence control -single phase and three phase cyclo converters – Introduction to Matrix converters.

Total: 45

Course Outcome

1. Ability to analyse AC-AC and DC-DC and DC-AC converters.
2. Ability to choose the converters for real time applications.

Text Books

1. M.H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, Third Edition, New Delhi, 2004.
2. P.S.Bimbra "Power Electronics" Khanna Publishers, third Edition, 2003.
3. Ashfaq Ahmed 'Power Electronics for Technology', Pearson Education, Indian reprint, 2003.

References

1. Joseph Vithayathil,' Power Electronics, Principles and Applications', McGraw Hill Series, 6th Reprint, 2013.
2. Philip T. Krein, "Elements of Power Electronics" Oxford University Press, 2004 Edition.
3. L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2010.
4. Ned Mohan Tore. M. Undel and, William. P. Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and sons, third edition, 2003.
5. S.Rama Reddy, 'Fundamentals of Power Electronics', Narosa Publications, 2014.
6. M.D. Singh and K.B. Khanchandani, "Power Electronics," Mc Graw Hill India, 2013.

21EEE11	Power System Analysis	L	T	P	C
		3	0	0	3

Course Objectives

1. To model the power system under steady state operating condition
2. To understand and apply iterative techniques for power flow analysis
3. To model and carry out short circuit studies on power system
4. To model and analyse stability problems in power system

Unit 1 – INTRODUCTION TO POWER SYSTEM MODELING **9**

Indian Scenario of Power System Transmission and Distribution - Basic Components of a power system– Steady state modelling of Power System components: Generator, Transformer and Transmission line - Per unit system - Change of base - Impedance Diagram and Reactance diagram.

Unit 2 - LOAD FLOW ANALYSIS **9**

Introduction – Classification of Buses - Bus admittance matrix – Power Flow Equation - Iterative solution to Power flow equation using Gauss seidal method - Newton Raphson method - Fast Decoupled Method - Comparison of Iterative methods. Suggested reading topics: Load flow solution using Fast Decoupled Method

Unit 3 – SYMMETRICAL FAULT ANALYSIS **9**

Introduction – Balanced three phase fault – Short circuit capacity – Symmetrical fault analysis using Thevenin method - Formation of the bus impedance matrix - Systematic fault analysis using bus impedance matrix. Selection of Circuit Breaker Suggested reading topics: Application of Series reactors.

Unit 4 – UN SYMMETRICAL FAULT ANALYSIS **9**

Introduction – Fundamentals of symmetrical components – sequence impedances – sequence networks– single line to ground fault – line to line fault - Double line to ground fault – Unbalanced fault analysis using bus impedance matrix. Suggested reading topics: Estimation of Sequence components

Unit 5 - STABILITY ANALYSIS **9**

Classification of power system stability – Rotor angle stability - Swing equation - Swing curve - Power-Angle equation - Equal area criterion - Critical clearing angle and time - Classical step-by-step solution of the swing equation – modified Euler method

Total: 45

Course Outcome

1. Ability to model the power system under steady state operating condition
2. Ability to understand and apply iterative techniques for power flow analysis
3. Ability to model and carry out short circuit studies on power system
4. Ability to acquire knowledge on Fault analysis.
5. Ability to model and understand various power system components and carry out power flow, short circuit and stability studies.

Text Books

1. John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', Mc Graw Hill Education (India) Private Limited, New Delhi, 2015.
2. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, Second Edition, 2008.
3. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

References

1. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
2. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012.
3. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.

21EEE12	Protection and Switchgear	L	T	P	C
		3	0	0	3

Course Objectives

1. Causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
2. Characteristics and functions of relays and protection schemes.
3. Apparatus protection, static and numerical relays
4. Functioning of circuit breaker

Unit 1 – PROTECTION SCHEMES **9**

Principles and need for protective schemes – nature and causes of faults – types of faults – Methods of Grounding - Zones of protection and essential qualities of protection – Protection scheme. Suggested Reading Topic: Symmetrical Faults on three phase systems.

Unit 2 – ELECTROMAGNETIC RELAYS **9**

Operating principles of relays - the Universal relay – Torque equation – R-X diagram – Electromagnetic Relays – Over current, Directional, Distance, Differential, Negative sequence and Under frequency relays. Suggested Reading Topic: Block diagram and working of Microprocessor based Over Current Relay.

Unit 3 – APPARATUS PROTECTION **9**

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, bus bars and transmission line. Suggested Reading Topic: Stator Inter Turn Protection.

Unit 4 – STATIC RELAYS AND NUMERICAL PROTECTION **9**

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, distant protection of transmission lines.

Unit 5 - CIRCUIT BREAKERS **9**

Physics of arcing phenomenon and arc interruption - DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching - current chopping - interruption of capacitive current - Types of circuit breakers – air blast, air break, oil, SF6, MCBs, MCCBs and vacuum circuit breakers – comparison of different circuit breakers – Rating and selection of Circuit breakers.

Total: 45

Course Outcome

1. Ability to understand and analyze Electromagnetic and Static Relays.
2. Ability to suggest suitability circuit breaker.
3. Ability to find the causes of abnormal operating conditions of the apparatus and system.
4. Ability to analyze the characteristics and functions of relays and protection schemes.
5. Ability to study about the apparatus protection, static and numerical relays.
6. Ability to acquire knowledge on functioning of circuit breaker.

Text Books

1. Sunil S.Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, 2008.
2. B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., First Edition 2011.
3. Arun Ingole, 'Switch Gear and Protection' Pearson Education, 2017.

References

1. BadriRam ,B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age InternationalPvt Ltd Publishers, Second Edition 2011.
2. Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Second Edition,Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
3. C.L.Wadhwa, 'Electrical Power Systems', 6th Edition, New Age International (P) Ltd., 2010
4. RavindraP.Singh, 'Switchgear and Power System Protection', PHI Learning Private Ltd., NewDelhi, 2009.

21EEE13	Microprocessor and Microcontroller	L	T	P	C
		3	0	0	3

Course Objectives

1. To familiarize the architecture of microprocessors and micro controllers.
2. To provide the knowledge about interfacing techniques of bus & memory.
3. To understand the concepts of ARM architecture.
4. To study the basic concepts of Advanced ARM processors.

Unit 1 – 8086 Architecture & Instruction Set and Assembly Language Programming *10*

8086 Architecture: 8086 Architecture-Functional diagram, Register Organization, Memory Segmentation, Programming Model, Memory addresses, Physical Memory Organization, Architecture of 8086, Signal descriptions of 8086, interrupts of 8086. Instruction Set and Assembly Language Programming of 8086: Instruction formats, Addressing modes, Instruction Set, Assembler Directives, Macros, and Simple Programs involving Logical, Branch and Call Instructions, Sorting, String Manipulations.

Unit 2 - Introduction to Microcontrollers & 8051 Real Time Control *10*

Introduction to Microcontrollers: Overview of 8051 Microcontroller, Architecture, I/O Ports, Memory Organization, Addressing Modes and Instruction set of 8051. Real Time Control: Programming Timer Interrupts, Programming External Hardware Interrupts, Programming the Serial Communication Interrupts, Programming 8051 Timers and Counters.

Unit 3 – I/O and Memory Interface & Serial Communication and Bus Interface *10*

I/O and Memory Interface: LCD, Keyboard, External Memory RAM, ROM Interface, ADC, DAC Interface to 8051.Serial Communication and Bus Interface: Serial Communication Standards, Serial Data Transfer Scheme, On board Communication Interfaces-I2C Bus, SPI Bus, UART; External Communication Interfaces-RS232,USB.

Unit 4 – ARM Architecture *10*

ARM Processor fundamentals, ARM Architecture – Register, CPSR, Pipeline, exceptions and interrupts interrupt vector table, ARM instruction set – Data processing, Branch instructions, load store instructions, Software interrupt instructions, Program status register instructions, loading constants, Conditional execution, Introduction to Thumb instructions.

Unit 5 - **Advanced ARM Processors** *5*

Introduction to CORTEX Processor and its architecture, OMAP Processor and its Architecture.

Total: 45

Course Outcome

1. Ability to understand the internal architecture, organization and assembly language programming of 8086 processors.
2. Ability to understand the internal architecture, organization and assembly language programming of 8051/controllers.
3. Ability to understand the interfacing techniques to 8086 and 8051 based systems.
4. Ability to understand the internal architecture of ARM processors and basic concepts of advanced ARM processors.

Text Books

1. Advanced Microprocessors and Peripherals – A. K. Ray and K. M. Bhurchandani, TMH, 2nd Edition 2006.
2. ARM System Developers guide, Andrew N SLOSS, Dominic SYMES, Chris WRIGHT, Elsevier, 2012 .

References

1. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, 2007.
2. B.RAM," Computer Fundamentals Architecture and Organization" New age International Private Limited, Fifth edition, 2017.
3. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.
4. Digital Signal Processing and Applications with the OMAP- L138 Experimenter, Donald Reay, WILEY 2012.

21EEEP6	Microprocessor and Microcontroller Lab	L	T	P	C
		0	0	4	2

Course Objectives

1. To provide training on programming of microprocessors and microcontrollers and understand the interface requirements.
2. To simulate various microprocessors and microcontrollers using KEIL or Equivalent simulator.

List of Experiments

1. Simple arithmetic operations: addition / subtraction / multiplication / division.
2. Programming with control instructions:
   - (i) Ascending / Descending order, Maximum / Minimum of numbers.
   - (ii) Programs using Rotate instructions.
   - (iii) Hex / ASCII / BCD code conversions.
3. Interface Experiments: with 8085
   - (i) A/D Interfacing. & D/A Interfacing.
4. Traffic light controller.
5. I/O Port / Serial communication
6. Programming Practices with Simulators/Emulators/open source
7. Read a key ,interface display
8. Demonstration of basic instructions with 8051 Micro controller execution, including:
   - (i) Conditional jumps & looping
   - (ii) Calling subroutines.
9. Programming I/O Port and timer of 8051
   - (i) study on interface with A/D & D/A
   - (ii) Study on interface with DC & AC motors
10. Application hardware development using embedded processors.

Total: 60

Course Outcome

1. Ability to understand and apply computing platform and software for engineering problems.
2. Ability to programming logics for code conversion.
3. Ability to acquire knowledge on A/D and D/A.
4. Ability to understand basics of serial communication.
5. Ability to understand and impart knowledge in DC and AC motor interfacing.
6. Ability to understand basics of software simulators.

21EEE14	Solid State Drives	L	T	P	C
		3	0	0	3

Course Objectives

1. Steady state operation and transient dynamics of a motor load system.
2. Analyze the operation of the converter/chopper fed dc drive, both qualitatively and quantitatively. Operation and performance of AC motor drives.
3. Analyze and design the current and speed controllers for a closed loop solid state DC motor drive.

Unit 1 – Characteristics of Motor Drive **9 Hours**

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor-Applications involving four quadrant operation.

Unit 2 – Dc Motor Drive **9 Hours**

Steady state analysis of the single and three phase fully controlled converter fed separately excited D.C motor drive: Continuous and discontinuous conduction mode Chopper fed D.C drive: Time ratio control and current limit control Operation of four quadrant chopper.

Unit 3 – Induction Motor Drives **9 Hours**

Stator voltage control–V/f control– Rotor Resistance control-qualitative treatment of slip power recovery drives-closed loop control–– vector control- Applications.

Unit 4 – Synchronous Motor Drives **9 Hours**

V/f control and self-control of synchronous motor: Margin angle control and power factor control-Three phase voltage/current source fed synchronous motor- Applications.

Unit 5 - Design Of Controllers For Drives **9 Hours**

Transfer function for DC motor / load and converter – closed loop control with Current and speed feedback–armature voltage control and field weakening mode – Design of controllers; current controller and speed controller- converter selection and characteristics.

Total: 45

Course Outcome

1. Ability to understand and suggest a converter for solid state drive.
2. Ability to select suitability drive for the given application.
3. Ability to study about the steady state operation and transient dynamics of a motor load system.
4. Ability to analyze the operation of the converter/chopper fed dc drive.
5. Ability to analyze the operation and performance of AC motor drives.
6. Ability to analyze and design the current and speed controllers for a closed loop solid state DC motor drive.

Text Books

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 1992.
2. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002.
3. R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson, 2001.

References

1. Vedam Subramanyam, " Electric Drives Concepts and Applications ", 2e, McGraw Hill, 2016
2. Shaahin Felizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis Group), 2013.
3. John Hindmarsh and Alasdain Renfrew, "Electrical Machines and Drives System," Elsevier 2012.
4. Theodore Wildi, " Electrical Machines ,Drives and power systems ,6th edition, Pearson Education ,2015

21EEEP7	Power Electronics & Drives Lab	L	T	P	C
		0	0	4	2

Course Objectives

- To acquire practice on modelling of power electronics converters and dc and ac motor drives.

List of Experiments

1. AC to DC half-controlled converter and fully controlled Converter.
2. Step down and step up MOSFET based choppers.
3. IGBT based three phase PWM inverter.
4. Simulation of PE circuits (1Φ & 3Φ semi converters, 1Φ & 3Φ full converters, DC-DC converters, AC voltage controllers).
5. Speed control of Converter fed DC motor.
6. V/f control of three-phase induction motor.
7. Micro controller-based speed control of Stepper motor.
8. Speed control of BLDC motor.
9. Direct Torque Control of Induction motor drive using digital simulation.
10. Four quadrant operation of DC Motor using digital simulation.

Total: 60

Course Outcome

1. Understand the operation of Power electronics Converters
2. Analyse the performance of Converter fed and Chopper fed DC motor drive.
3. Analyse the performance of Induction motor drive.
4. Analyse the performance of stepper motor and BLDC motor drive.
5. Understand the operation of four quadrant chopper using simulation software.

21EEEMP	Mini Project	L	T	P	C
		0	0	2	1

Course Objectives

1. To develop their own innovative prototype of ideas.
2. To train the students in preparing mini project reports and examination.

The students in a group of 5 to 6 works on a topic approved by the head of the department and prepares a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

Total: 30

Course Outcome

1. On Completion of the mini project work students will be in a position to take up theirfinal year project work and find solution by formulating proper methodology.

21EEE15	Power System Operation and Control	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the fundamentals of power system operation.
- To get the insight of load frequency control and its modelling.
- To provide knowledge about reactive power-voltage interaction and the control actions
- To study the economic operation of power system
- To be familiar with the power system security issues and contingency studies.

Unit 1 – Introduction to Power System Performance and Operation 9

System load characteristics, load curves, load-duration curve, load factor, diversity factor. Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves. Load forecasting, unit commitment, load dispatching. Governor control, LFC, EDC, AVR, system voltage control, security control.

Unit 2 – Automatic Generation Control 9

Speed-load characteristics, Load sharing 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 modeling, static analysis, uncontrolled case and tie line with frequency bias control of state variable model

Unit 3 - Automatic voltage control 9

Typical excitation system, modeling, static and dynamic analysis, stability compensation, generation and absorption of reactive power, Relation between voltage, power and reactive power; Injection of reactive power and MVAR injection of switched capacitors-maintain voltage profile – minimize transmission loss.

Unit 4 - Unit Commitment and Economic Dispatch 9

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. Incremental cost curve, co- ordination equations without loss and with loss, solution by direct method and λ-iteration method. Gradient method- Newton's method – Base point and participation factor method. Economic dispatch controller added to LFC control.

Unit 5 - Power System Security 9

Need for power system Security- - Contingency analysis – linear sensitivity factors – AC power flow methods – contingency selection – concentric relaxation – bounding-security constrained optimal power flow-Interior point algorithm-Bus incremental costs.

Total: 45

Course Outcome

1. Explain about the operation and control of power system
2. Develop the static and dynamic model of Load Frequency Control in single and multi-area system
3. Analyze the components which affect reactive power, voltage control methods, relationship between voltage and reactive power
4. Distinguish between various methods involved in unit commitment and economic dispatch problems
5. Define about the power system security factors and analyse the algorithms used for optimal power flow

Text Books

1. Allen.J.Wood and Bruce F.Wollenberg, 'Power Generation, Operation and Control', 3rd/e, John Wiley & Sons, Inc., 2013
2. D P Kothari, I J Nagrath, "Modern Power System Analysis", Publisher Name, 3rd Edition, 2011
3. Robert H. Miller, James H. Malinowski, 'Power system operation', Tata McGraw-Hill, 2009

References

1. P S R Murthy, ‘Operation and Control in Power Systems’, BS Publications; Leiden : CRC Press, cop. 2011.
2. L.L. Grigsby, ‘The Electric Power Engineering Hand Book’, 3rd/e, CRC Press &IEEE Press, 2012.
3. Leonard L Grigsby, ‘Power System Stability & Control’, Third edition, Boca Raton, Fla. : CRC Press, 2012

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21EEEP8	Power System Simulation Lab	L	T	P	C
		0	0	4	2

Course Objectives

1. To learn design, testing and characterizing of circuit behaviour with digital and analog ICs.

List of Experiments

1. Formation of Y Bus Matrix
2. Formation of Z Bus Matrix
3. Load Flow Analysis by Gauss – Seidal Method
4. Load Flow Analysis by Newton – Raphson Method
5. Fault Analysis
6. Computation of Transmission Line Parameters
7. Modeling of Transmission Line
8. Load Frequency Control of Single Area System
9. Load Frequency Control of Two Area System
10. Transient Stability Analysis of Multi Machine Power System
11. Small Signal Stability Analysis of Single Machine Infinite Bus System
12. Economic Dispatch in Power System

Total: 60

Course Outcome

1. Ability to acquire knowledge on Formation of Bus Admittance and Impedance Matrices and Solution of Networks.
2. Ability to analyze the power flow using GS and NR method
3. Ability to find Symmetric and Unsymmetrical fault
4. Ability to understand the economic dispatch.
5. Ability to analyze load frequency control.

21EEE16	Fluid Mechanics and Thermal Engineering	L	T	P	C
		3	0	0	3

Course Objectives

- To make the students to understand the principles of solid mechanics.
- To make the students to understand the basic concepts of mechanical vibrations.
- To familiarize the students with the properties of fluids and the applications of fluid mechanics.
- To make the students to understand the principles of thermodynamics and to get broad knowledge in its applications.
- To provide the students a gist of the theory behind the refrigeration and air conditioning system.
- To make the students to understand the principles of heat transfer.

Unit 1 - Fluid Mechanics **9 Hours**

Properties of fluid- Uniform and steady flow- Euler's and Bernoulli's Equations- pressure losses along the flow. Flow measurement- Venturi meter and Orifice meters, Pipes in series and parallel. Introduction to Turbines and pumps - classification of turbines - specific speed and speed governance. Classification of pumps- characteristics and efficiency.

Unit 2 - Thermodynamic systems **9 Hours**

Basic concepts of Thermodynamics - First law of thermodynamics– Second law of thermodynamics - applications. Working Principle of four stroke and two stroke engines - Open and closed cycle gas turbines

Unit 3 – Steam Boilers and Turbines **9 Hours**

Formation of steam – Thermal power plant – Boilers -Modern features of high-pressure boilers - Mountings and accessories - Steam turbines: Impulse and reaction principle.

Unit 4 – Compressors, Refrigeration and Air conditioning **9 Hours**

Air Compressors- Principle of operation of reciprocating, centrifugal and axial flow compressors - Basic functions of refrigeration- Vapour Compression and Vapour absorption systems-Principle of air conditioning system- Types and comparison.

Unit 5 - Heat Transfer **9 Hours**

Fundamentals of heat transfer-conduction, convection and radiation - Free convection and forced convection - Applications like cooling of electronic components, electric motor and transformers

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Assess the vibrations associated with various mechanical systems.
- Apply the fundamental laws of thermodynamics for the analysis of wide range of thermodynamic systems.
- Explain basic concepts of fluid mechanics and their applications.
- Demonstrate and analyze various refrigeration and air conditioning systems.
- Evaluate heat transfer through different modes.

Text Books

1. R.K. Rajput, Thermal Engineering, Lakshmi Publications, 2010
2. R.K. Bansal, Fluid Mechanics & Hydraulic Engineering, Khanna Publishers,

References

1. Rogers and Mayhew, 'Engineering Thermodynamics – Work and Heat Transfer', Addision Wesley, New Delhi, 1999.
2. B.K. Sarkar, 'Thermal Engineering', Tata McGraw Hill, New Delhi, 1998.

21EEE17	Material Science	L	T	P	C
		3	0	0	3

Course Objectives

- To enable the students to understand the nature of different types of materials namely Conducting, Semi conducting, Dielectrics, Magnetic and Superconducting materials.

Unit 1 - Conducting Materials **9 Hours**

Drude-Lorentz Classical free electron theory of metals, electrical conductivity, relaxation time, drift velocity, Matthiessen's rule, thermal conductivity Wiedemann-Franz law, drawbacks of classical theory, Kronig-Penny Model, Quantum theory (derivation) and its success, Band theory of solids.

Unit 2 - Semiconducting Materials **9 Hours**

Band theory of solids – Kronig-Penney Model & its success; P and N type – direct and indirect semiconductor; Density of energy state; Variation of Fermi level with respect to temperature and carrier concent rat ion in intrinsic and extrinsic semiconductors; Hall effect – theory – experimental proof; Hall Sensors, Problems

Unit 3 – Dielectric Materials **9 Hours**

Introduction, Clausius- Mosotti relation; Polarization mechanisms, electronic, ionic and orientation, Temperature dependence of dielectric constant, Frequency dependence of dielectric constant, Dielectric loss, dielectric breakdown types, dielectric materials as electrical insulators -examples, Problems, Ferroelectric and Piezoelectric materials

Unit 4 – Magnetic & Superconducting Materials **10 Hours**

Magnetic parameters and their relations - Origin of magnetization– orbital magnetic, moment, spin magnetic moment, Bohr magneton, Properties of dia, para, ferro, antiferro and ferromagnetic materials - Domain theory of ferromagnetism, Hysteresis, soft and hard magnetic materials, Application-computer hard disk.

Superconductors, types, properties, Meissner Effect, BCS theory, High Tc Superconductors (YBCO). Applications- Josephson Effect-SQUID-Cryotron; Problems.

Unit 5 - Metamaterials & Material Synthesis **9 Hours**

Introduction, Natural and Artificial Materials, Photonic Bandgap Materials, Equivalent plasma frequency of a wire medium, Resonant elements for metamaterials, Polarizability of a current - carrying resonant loop, Effective permeability, Effect of negative materials constants.

Material synthesis processes, PVD sputtering, Chemical Vapour deposition (CVD), Examples: preparation of thin films, bulk and nanomaterials (any one material)

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- understand the fundamentals of physics for conducting materials and how it is pertinent for engineering related applications
- describe the basic classification of semiconducting materials and how to develop an engineering related devices
- Analysis of various magnetic properties and its applications.
- Describe the phenomenon of super conduction and explain how superconductors behave in magnetic fields including some engineering applications of superconductors.
- Gain an introduction to nanomaterials and in depth knowledge about synthesis and properties of bulk and nanostructured materials, including their applications.

Text Books

1. C.M. Srivasta and Srinivasan, “Science of Engineering Materials”, Tata McGraw Hill Publications, 2003.
2. M S Vijaya & G Rangarajan, “Materials Science”, Tata McGraw – Hill Publishing Company Ltd., 2003.
3. Electrical Properties of Materials (eighth edition, 2010), L. Solymar and D. Walsh (Oxford university Press)

References

1. S.O. Kasap, “Principles of Electronic Materials and devices”, Second edition, Tata McGraw – Hill Publishing Company Ltd., 2002.
2. M S Vijaya & G Rangarajan, “Materials Science”, Tata McGraw – Hill Publishing Company Ltd., 2003.
3. Materials Science of Thin Films, Milton Ohring, Academic Press, 2002

21EEE18	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

- Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

Unit 1 – COAL BASED THERMAL POWER PLANTS **9**

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

Unit 2 - DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS **9**

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

Unit 3 –NUCLEAR POWER PLANTS **9**

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

Unit 4 – POWER FROM RENEWABLE ENERGY **9**

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

Unit 5 - ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS **9**

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

Total: 45

Course Outcome

- Ability to understand the layout, construction and working of the components inside a thermal power plant.
- Ability to understand the components inside a Diesel, Gas and Combined cycle power plants.
- Understands the concepts of nuclear power plants.
- Understands the layout, construction and working of the components inside Renewable energy power plants.
- Knowledge in power plant economics and environmental hazards and estimate the costs of electrical energy production.

Text Books

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.
2. Generation of Electrical Energy by B.R. Gupta, S. Chand & Company Ltd, 2014, 5th Edition.

References

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.

21EEE19	Robotics and Control	L	T	P	C
		3	0	0	3

Course Objectives

- To develop the student's knowledge in various robot structures and their workspace.
- To develop student's skills in performing spatial transformations associated with rigid body motions & some knowledge and analysis skills associated with trajectory planning.
- To develop student's skills in performing kinematic analysis of robotic systems and some knowledge and skills associated with robot control

Unit 1- Introduction **6 Hours**

Brief History, Types of robots, Degrees of freedom of robots, Robot configurations and concept of workspace, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots

Unit 2 - Rigid Motion and Homogeneous transformation **9 Hours**

Position definitions. Coordinate frames. Different orientation descriptions. Free vectors. Translations rotations and relative motion, Composition of rotation, rotation with respect to fixed frame and current frame, parameterisation of rotation, Euler Angele, roll, pitch, yaw, axis/angle representation, Homogeneous transformation

Unit 3 – Forward & Velocity Kinematics **11 Hours**

Link coordinate frames. Denavit-Hartenberg convention. Assignment, of coordinate frame, Joint and end effector Cartesian space. Calculation of DH parameters and forward kinematic equation of different configuration of manipulator, Planner elbow manipulator, Cylindrical three link, SCARA, Spherical Wrist and other configuration.
Forward kinematics transformations of position Translational and rotational velocities. Velocity Transformations. Singularity, The Manipulator Jacobian.

Unit 4 – Robot Dynamics & Independent Joint Control **11 Hours**

Lagrangian formulation, general expression for kinetic and potential energy of n-link manipulator, Newton-Euler equations of motion. Derivation of equations of motion for simple cases: two-link manipulators.
Actuator dynamics, Set point tracking Feed forward control, Drive Train dynamics. Introduction to force control and multivariable control.

Unit 5 -Trajectory Planning& Programming **8 Hours**

Trajectory planning and avoidance of obstacles. Trajectory for point to point motion, Cubic polynomial trajectory, Quantic polynomial, LSPB (Linear segment with parabolic blend) Minimum time trajectory, Trajectories for Paths Specified by Via Points. Robot languages, computer control and Robot software

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Demonstrate the knowledge of different types of sensors and actuators used in robotic systems
- Apply spatial transformation to obtain the forward kinematic equation of robot manipulators.
- Identify the dynamics of the robotic manipulator using Euler Lagrangian approach
- Demonstrate an ability to generate joint trajectories for motion planning.

- Implement the multivariable controller for setpoint tracking and disturbance rejection.

Text Books

1. M.W. Spong, S. Hutchinson, and M. Vidyasagar, Robot Modeling and Control, Wiley, 2nd revise edition, 2012
2. J.J. Craig, Introduction to Robotics: Mechanics and Control, Pearson Education, 4th Edition, 2017
3. M.P. Groover, et.al., Industrial Robots: Technology, Programming and applications, McGraw Hill, 2nd indian edition, 2012.

References

1. Etienne Dombre; Wisama Khalil, Somerset, Robot Manipulators: Modeling, Performance Analysis and Control, Wiley, 2013.
2. M O Tokhi, A K M Azad,Flexible robot manipulator :modelling,simulation and control 2nd edition, 2017
3. Ashitava Ghosal.Robotic fundamental Concept and Analysis,Oxford University Press 11th impression 2015.

21EEE20	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

Unit 1 – STATICS OF PARTICLES **9**

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

Unit 2 - EQUILIBRIUM OF RIGID BODIES **9**

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

Unit 3 –PROPERTIES OF SURFACES AND SOLIDS **9**

Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula – Theorems of Pappus - Area moments of inertia of plane areas – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia–mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

Unit 4 – DYNAMICS OF PARTICLES **9**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

Unit 5 - FRICTION AND RIGID BODY DYNAMICS **9**

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

Total: 45

Course Outcome

- Ability to understands the vectorial and scalar representation of forces and moments
- Ability to analyse the rigid body in equilibrium.
- Ability to evaluate the properties of surfaces and solids.
- Ability to calculate dynamic forces exerted in rigid body.
- Ability to determine the friction and the effects by the laws of friction.

Text Books

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010).

References
1. Bhavikatti, S.S and Rajashekarappa, K.G., “Engineering Mechanics”, New Age International (P) Limited Publishers, 1998. 2. Hibbeller, R.C and Ashok Gupta, “Engineering Mechanics: Statics and Dynamics”, 11th Edition, Pearson Education 2010. 3. Irving H. Shames and Krishna Mohana Rao. G., “Engineering Mechanics – Statics and Dynamics”, 4th Edition, Pearson Education 2006. 4. Meriam J.L. and Kraige L.G., “ Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2”, Third Edition, John Wiley & Sons,1993.

21EEE21	Signals & Systems	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basic properties of signal & systems.
- To know the methods of characterization of LTI systems in time domain.
- To analyze continuous time signals and system in the Fourier and Laplace domain.
- To analyze the signals and systems using Z transform.

Unit 1 - Classification of Signals and Systems **10 Hours**

Continuous-Time and Discrete-Time signals–The Unit Impulse Unit Step, Unit Ramp Signals and other Basic Signals – Operation of Signals -Time Shifting – Time Reversal – Amplitude Scaling – Time Scaling – Continuous- Time and Discrete-Time Systems– Basic System Properties - Systems with and Without Memory – Causality – Stability – Time Invariance – Linearity.

Unit 2 - Linear Time- Invariant Systems **10 Hours**

Discrete-Time LTI system: The Convolution sum-tabulation method-matrix multiplication method-graphical and analytical approach – Solution of Difference Equations.
Continuous Time LTI Systems: The Convolution Integral - graphical and analytical approach – Properties of Linear Time-Invariant Systems – Solution of Differential Equations.

Unit 3 – Analysis of CT Signals using Fourier Series & Fourier Transform **9 Hours**

Fourier Series Representation (Trigonometric) of Continuous-Time Periodic Signals – Properties of Continuous-Time Fourier Series – Representation of Aperiodic Signals: The Continuous-Time Fourier Transform – The Fourier Transform for Periodic Signals – Properties of the Continuous-Time Fourier Transform – Convolution Property – The Multiplication Property.

Unit 4 – Analysis of Signals and Systems using Laplace Transform **7 Hours**

The Laplace Transform – The Region of Convergence for Laplace Transform– The Inverse Laplace Transform using Partial fraction– Properties of the Laplace Transform

Unit 5 - Analysis of Signals and Systems using Z-Transform **7 Hours**

The Z-Transform – The Region of Convergence for the Z-Transform –The Inverse Z Transform using Partial fraction and long division method– Properties of the Z-Transform

Total: 45

Course Outcome

At the end of the course student will be able

- Classify the signals as continuous time and discrete time signals and classify systems based on their properties.
- Determine the response of LTI system using convolution sum for DT system and Convolution Integral for CT system
- Apply Fourier series and Fourier Transform for periodic Signals
- Analyze system using Laplace transform and realize the structure for CT system
- Analyze system using Z transform and realize the structure for DT system

Text Books

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, “Signals and Systems”, 2nd E, Prentice Hall India, 2019.
2. A.Anand Kumar, “Signals and Systems”, 3rd Edition, Prentice Hall India, 2018.

References
1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms, and Applications", 4th E, PHI, 2012 2. Robert A. Gable, Richard A. Roberts, "Signals & Linear Systems", 3rd E, John Wiley, 2014. 3. W Kamen& Bonnie's Heck, "Fundamentals of Signals and Systems", Pearson Education, 2016.

21EEE22	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives

- Signals and systems & their mathematical representation.
- Discrete time systems.
- Transformation techniques & their computation.
- Filters and their design for digital implementation.
- Programmability digital signal processor & quantization effects.

Unit 1 – INTRODUCTION **9**

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

Unit 2 - DISCRETE TIME SYSTEM ANALYSIS **9**

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Discrete Time Fourier transform , magnitude and phase representation.

Unit 3 – DISCRETE FOURIER TRANSFORM & COMPUTATION **9**

Discrete Fourier Transform- properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT &DIF using radix 2 FFT – Butterfly structure.

Unit 4 – DESIGN OF DIGITAL FILTERS **9**

FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. Analog filter design – Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation Warping, pre-warping.

Unit 5 - DIGITAL SIGNAL PROCESSORS **9**

Introduction – Architecture – Features – Addressing Formats – Functional modes - Introduction to Commercial DS Processors

Total: 45

Course Outcome

- Ability to understand the importance of Fourier transform, digital filters and DS Processors.
- Ability to acquire knowledge on Signals and systems & their mathematical representation.
- Ability to understand and analyze the discrete time systems.
- Ability to analyze the transformation techniques & their computation.
- Ability to understand the types of filters and their design for digital implementation.
- Ability to acquire knowledge on programmability digital signal processor & quantization effects.

Text Books

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, PHI. 2003.
2. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', McGraw Hill Edu, 2013.
3. Lonnie C.Ludeman ,"Fundamentals of Digital Signal Processing",Wiley,2013

References

1. Poorna Chandra S, Sasikala. B, Digital Signal Processing, Vijay Nicole/TMH, 2013.
2. Robert Schilling & Sandra L.Harris, Introduction to Digital Signal Processing using Matlab", Cengage Learning, 2014.
3. B.P.Lathi, 'Principles of Signal Processing and Linear Systems', Oxford University Press, 2010
4. Taan S. ElAli, 'Discrete Systems and Digital Signal Processing with Mat Lab', CRC Press, 2009.
5. SenM.kuo, woonseng…s.gan, "Digital Signal Processors, Architecture, Implementations & Applications, Pearson, 2013
6. DimitrisG.Manolakis, Vinay K. Ingle, applied Digital Signal Processing,Cambridge, 2012

21EEE23	EMBEDDED SYSTEMS DESIGN	L	T	P	C
		3	0	0	3

Course Objectives

To impart knowledge on the following Topics

- Building Blocks of Embedded System
- Various Embedded Development Strategies
- Bus Communication in processors, Input/output interfacing.
- Various processor scheduling algorithms.
- Basics of Real time operating system and example tutorials to discuss on one real time operating system tool.

Unit 1 – INTRODUCTION TO EMBEDDED SYSTEMS **9**

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

Unit 2 - EMBEDDED NETWORKING **9**

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers.

Unit 3 – EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT **9**

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object-oriented Model.

Unit 4 – RTOS BASED EMBEDDED SYSTEM DESIGN **9**

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance.

Unit 5 - EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT **9**

Case Study of Washing Machine- Automotive Application- Smart card System Application-ATM machine –Digital camera.

Total: 45

Course Outcome

- Ability to understand and analyze embedded systems.
- Ability to suggest an embedded system for a given application.
- Ability to operate various Embedded Development Strategies
- Ability to study about the bus Communication in processors.
- Ability to acquire knowledge on various processor scheduling algorithms.
- Ability to understand basics of Real time operating system.

Text Books
1. Peckol, “Embedded system Design”, John Wiley & Sons,2010 2. Lyla B Das,” Embedded Systems-An Integrated Approach”, Pearson, 2013 3. Shibu. K.V, “Introduction to Embedded Systems”, 2e, Mc graw Hill, 2017.
References
1. Raj Kamal, ‘Embedded System-Architecture, Programming, Design’, Mc Graw Hill, 2013. 2. C.R.Sarma, “Embedded Systems Engineering”, University Press (India) Pvt. Ltd, 2013. 3. Tammy Noergaard, “Embedded Systems Architecture”, Elsevier, 2006. 4. Han-Way Huang, “Embedded system Design Using C8051”, Cengage Learning, 2009. 5. Rajib Mall “Real-Time systems Theory and Practice” Pearson Education, 2007.

21EEE24	Advanced Digital System Design With FPGAs	L	T	P	C
		3	0	0	3

Course Objectives

- To learn complex digital systems using Hardware Description Language.
- To learn field programmable gate array (FPGA) technologies and utilize associated computer aided design (CAD) tools to synthesize and analyze digital systems.

Unit 1 -Introduction to FPGAs — **9 Hours**

Basic Programmable Logic architectures, Complex Programmable Logic Devices (CPLDs), Field Programmable Gate Arrays (FPGAs), Design Flow, Design Tools.

Unit 2 -Introduction to Verilog HDL — **9 Hours**

Review of Verilog HDL, Modeling styles: Behavioural, Dataflow, and Structural Modeling, gate delays, switch-level Modeling, Hierarchal structural modeling.

Unit 3 - MSI Combinational Logic Blocks & Sequential Circuits — **9 Hours**

Multiplexer, DeMultiplexer, Encoder, Decoder, ROM, PAL, PLA.
Flip-Flops, Shift Registers, Counters, Finite State Machine Modelling.

Unit 3 –Arithmetic Circuit Design — **9 Hours**

Adders and Substractors, Multiplication Digital Signal Processing modules: FIR and IIR Filters, Bus structures, Synchronous & Asynchronous data transfer, UART baud rate generator, A simple CPU design.

Unit 4 – Verification — **9 Hours**

Functional verification, simulation types, Test Bench design, value change dump (VCD) files.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Design and recognize the trade-offs involved in digital design flows for system
- Compile and synthesize Verilog HDL.
- Design state machines to control complex systems.
- Verify Verilog test bench to test Verilog modules.
- Build a synchronous DSP system in Verilog and verify its performance.
- Design a floating point arithmetic using the IEEE-754 Standard.

Text Books

1. Michael D Ciletti, “Advanced Digital Design with the Verilog HDL” Prentice Hall, 2nd Edition, 2011.
2. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis” Pearson, Second Edition, 2009.

References

1. Stephen Brown & Zvonko Vranesic, “Fundamentals of digital Logic with Verilog Design” TATA Mc Graw Hill Ltd. 3rd Edition 2014.
2. Ming-Bo Lin., Digital System Designs and Practices Using Verilog HDL and FPGAs. Wiley, 2008.
3. Woods, R., McAllister, J., Yi, Y. and Lightbody, G. FPGA-based implementation of signal processing systems. John Wiley & Sons, 2017.

21EEE25	SMPS AND UPS	L	T	P	C
		3	0	0	3

Course Objectives

To impart knowledge about the following topics

- Modern power electronic converters and its applications in electric power utility.
- Resonant converters and UPS

Unit 1 – DC-DC CONVERTERS 9

Principles of step down and step up converters – Analysis and state space modeling of Buck, Boost, Buck- Boost and Cuk converters.

Unit 2 - SWITCHED MODE POWER CONVERTERS 9

Analysis and state space modeling of fly back, Forward, Push pull, Luo, Half bridge and full bridge converters- control circuits and PWM techniques.

Unit 3 – RESONANT CONVERTERS 9

Introduction- classification- basic concepts- Resonant switch- Load Resonant converters- ZVS , Clamped voltage topologies- DC link inverters with Zero Voltage Switching- Series and parallel Resonant inverters- Voltage control.

Unit 4 – DC-AC CONVERTERS 9

Single phase and three phase inverters, control using various (sine PWM, SVPWM and PSPWM) techniques, various harmonic elimination techniques- Multilevel inverters- Concepts - Types: Diode clamped- Flying capacitor- Cascaded types- Applications.

Unit 5 - POWER CONDITIONERS, UPS & FILTERS 9

Introduction- Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors.

Total: 45

Course Outcome

- Ability to analyze the state space model for DC – DC converters
- Ability to acquire knowledge on switched mode power converters.
- Ability to understand the importance of Resonant Converters.
- Ability to analyze the PWM techniques for DC-AC converters
- Ability to acquire knowledge on modern power electronic converters and its applications in electric power utility.
- Ability to acquire knowledge on filters and UPS

Text Books

1. Simon Ang, Alejandro Oliva," Power-Switching Converters", Third Edition, CRC Press, 2010.
2. KjeldThorborg, "Power Electronics – In theory and Practice", Overseas Press, First Indian Edition 2005.
3. M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001.

References

1. Philip T Krein, " Elements of Power Electronics", Oxford University Press

2. Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics converters, Applications and design- Third Edition- John Wiley and Sons- 2006

3. M.H. Rashid – Power Electronics circuits, devices and applications- third edition Prentice Hall of India New Delhi, 2007.

4. Erickson, Robert W, "Fundamentals of Power Electronics", Springer, second edition, 2010.

21EEE26	Utilization and Conservation of Electrical Energy	L	T	P	C
		3	0	0	3

Course Objectives

To impart knowledge on the following Topics

- To study the generation, conservation of electrical power and energy efficient equipments.
- To understand the principle, design of illumination systems and energy efficiency lamps.
- To study the methods of industrial heating and welding.
- To understand the electric traction systems and their performance.

Unit 1 – ILLUMINATION **9**

Importance of lighting – properties of good lighting scheme – laws of illumination – photometry - types of lamps – lighting calculations – basic design of illumination schemes for residential, commercial, street lighting, factory lighting and flood lighting – LED lighting and energy efficient lamps.

Unit 2 - REFRIGERATION AND AIR CONDITIONING **9**

Refrigeration-Domestic refrigerator and water coolers - Air-Conditioning-Various types of air-conditioning system and their applications, smart air conditioning units - Energy Efficient motors: Standard motor efficiency, need for efficient motors, Motor life cycle, Direct Savings and payback analysis, efficiency evaluation factor.

Unit 3 – HEATING AND WELDING **9**

Role of electric heating for industrial applications – resistance heating – induction heating – dielectric heating - electric arc furnaces. Brief introduction to electric welding – welding generator, welding transformer and the characteristics.

Unit 4 – TRACTION **9**

Merits of electric traction – requirements of electric traction system – supply systems – mechanics of train movement – traction motors and control – braking – recent trends in electric traction

Unit 5 - DOMESTIC UTILIZATION OF ELECTRICAL ENERGY **9**

Domestic utilization of electrical energy – House wiring. Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing – Domestic, Industrial and Substation.

Total: 45

Course Outcome

- To understand the main aspects of generation, utilization and conservation.
- To identify an appropriate method of heating for any particular industrial application.
- To evaluate domestic wiring connection and debug any faults occurred.
- To construct an electric connection for any domestic appliance like refrigerator as well as to design a battery charging circuit for a specific household application.
- To realize the appropriate type of electric supply system as well as to evaluate the performance of a traction unit.
- To understand the main aspects of Traction.

Text Books

1. Wadhwa, C.L. “Generation, Distribution and Utilization of Electrical Energy”, New Age International Pvt. Ltd, 2003.
2. Dr. Uppal S.L. and Prof. S. Rao, ’Electrical Power Systems’, Khanna Publishers, New Delhi, 15th Edition, 2014.
3. Energy Efficiency in Electric Utilities, BEE Guide Book, 2010

References

1. Partab.H, “Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Co, New Delhi, 2004.
2. Openshaw Taylor.E, “Utilization of Electrical Energy in SI Units”, Orient Longman Pvt. Ltd, 2003.
3. Gupta.J.B, “Utilization of Electric Power and Electric Traction”, S.K.Kataria and Sons, 2002.
4. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council.

21EEE27	HVDC and FACTS	L	T	P	C
		3	0	0	3

Course Objectives

- Understand the importance of controllable parameters and benefits of FACTS controllers.
- Identify the significance of HVDC over HVAC transmission systems, types, control and application of HVDC links in practical power systems.

Unit 1 -Introduction **9 Hours**

Control of power flow in transmission lines, Application and classification of FACTS controllers. Introduction to HVDC transmission- Comparison between HVDC and HVAC systems

Unit 2 - Shunt and Series connected Devices **9 Hours**

Shunt compensation : Methods of controllable VAR generation, Static Var Compensator, STATCOM, series compensation: GCSC, TSSC, TCSC and SSSC

Unit 3 – Combined controllers **9 Hours**

Unified Power Flow Controller, Interline Power Flow Controller and Generalized Unified Power Flow Controller, SSR Theory and Mitigation using FACTS controllers

Unit 4 – HVDC Transmission **9 Hours**

Introduction to CSI and VSI based HVDC Controllers. Converter control, Configuration of HVDC system Recent Trends in HVDC transmission, HVDC systems in India.

Unit 5 - DC Links **9 Hours**

Types of DC links, Back to back HVDC connections. Multi-terminal HVDC systems

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Study the applications of FACTS Controllers in power flow
- Significance of shunt & series compensation and role of FACTS devices on system control.
- Discuss the principles, operation and control of UPFC and IPFC & the SSR
- Explain the HVDC concepts, application of HVDC systems in bulk power transmission.
- Classify the DC links and describe the operation of various MTDC systems.

Text Books

3. K.R.Padiyar,"HVDC Power Transmission Systems “ New Academic Science , 2017
4. Narain Hingorani & Lazzlo Gyugi “Understanding FACTS. Concepts & Technology of
5. FACTS”, Standard publishers & distributors, 2001.

References

1. R.MohanMathur, Rajiv.K.Varma, “Thyristor Based FACTS Controllers for Electrical Transmission systems” John Wiley and Sons, 2011.
2. Jos Arrillaga, Y. H. Liu, Neville R. Watson " Flexible Power Transmission: The HVDC Options”, Wiley 2007.

21EEE28	Energy Audit and Conservation	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the energy audit and energy saving concept in electrical system
- To understand the energy scenario and Electricity Acts
- To understand the effect of over exploitation of energy resources

Unit 1 - Energy Scenario **9 Hours**

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, Energy security, energy conservation and its importance, energy strategy for the future, Energy Conservation Act 2001 and its features.

Unit 2 - Energy Management & Audit **9 Hours**

Energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering.

Unit 3 –Energy Monitoring and Targeting **9 Hours**

Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS)

Unit 4 – Energy conservation in Buildings **9 Hours**

Energy Conservation Building Codes (ECBC), building envelope, insulation, lighting, Heating, ventilation, air conditioning (HVAC), fenestrations, water pumping, inverter and energy storage/captive generation, elevators and escalators, star labeling for existing buildings.

Unit 5 - Financial Management **9 Hours**

Investment-need, appraisal and criteria, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs)

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Infer on Indian Energy Policy and Electricity ACT.
- Explain needs of energy management through energy audit.
- Estimate the energy consumption and detail the energy saving opportunities
- Interpret ECBC for various Buildings & Support firms with HVAC specifications.

Text Books

1. Energy Engineering and Management Amlan Chakrabarti Prentice hall India 2011
2. Bureau of energy efficiency, "General Aspects of Energy Management & Energy Audit", old edition on2005& new edition on2011
3. Course Material for Energy Audit and Managers Exam, Vol. 1-4 Energy Audit Manual the Practitioner's Guide Jointly published by EMC and NPC, 2017.

References

1. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, “Guide to Energy Management", the Fairmont Press, Inc, 2016.
2. Albert Thumann, Terry Niehus, William Younger, “Handbook of Energy Audits” The Fairmont Press, Inc, 2013.

21EEE29	Restructured Power Systems	L	T	P	C
		3	0	0	3

Course Objectives

- Overview of the restructuring and different restructuring models.
- Stranded costs, market operations, and transmission pricing and congestion management.
- Introduce the various restructuring models of power systems
- Introduce the restructuring process taken place in international scenario with pricing concepts.
- Introduce the current scenario of deregulation in Indian Power sector.

Unit 1 - Power System Restructuring **9 Hours**

Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behaviour - Supplier behaviour - Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models: Market models based on contractual arrangements - Market architecture

Unit 2 - Transmission Congestion Management **9 Hours**

Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods – Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method. G

Unit 3 – Locational Marginal Prices And Financial Transmission Rights **9 Hours**

Fundamentals of locational marginal pricing - Lossless DCOPF model for LMP calculation - Loss compensated DCOPF model for LMP calculation - ACOPF model for LMP calculation - Risk Hedging Functionality Of financial Transmission Rights - FTR issuance process - Treatment of revenue shortfall - Secondary trading of FTRs - Flow Gate rights - FTR and market power

Unit 4 – Ancillary service Management **9 Hours**

Classification of Ancillary services as per NERC – Load generation balancing related services services – Voltage control and reactive power support devices – Black start capability service NERC standards CPS1 and CPS2

Unit 5 - Reforms in Indian Power Sector **9 Hours**

Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – players in the Indian power system, Open access issues – Power exchange – Reforms in the near future

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Describe the requirement for deregulation of the electricity market and the principles of market models in power systems.
- Analyze the methods of congestion management in deregulated power system
- Analyze the locational marginal pricing and financial transmission rights
- Analyze the ancillary services management
- Differentiate the framework of US and Indian power sectors

Text Books

1. Mohammad Shahidepour Mueaffaq Alomoush, Marcel Dekker, “Restructured Electrical power systems Operation, Trading and Volatility ", CRC Press; 1st edition, 2001.
2. Kankar Bhattacharya, Math H.J. Boolen, Jaap E. Daadler, “Operation of restructured power systems ", Kluwer Academic publishers, 2012.
3. Paranjothi, S.R., “Modern Power Systems The Economics of Restructuring”, New Age International Publishers, First Edition: 2017.

References

1. Marija Illic, Francisco Galiana and Lester fink, “Power System Restructuring Engineering and Economics ", Kluwer Academic publishers, USA 2013.
2. .Venkatesh, B.V.Manikantan, S.Charles raja, “Electrical Power systems Analysis, security and deregulation ", PHI Learning private limited, New Delhi 2012.
3. Loi Lei Lai ,John, " Power System Restructuring and deregulation Trading, Performance and information Technology ", John Wiley &Sons Ltd ,England ,2001.

21EEE30	Energy Management and SCADA	L	T	P	C
		3	0	0	3

Course Objectives

- Make the students familiar with the preparatory work necessary for meeting the next day's operation and the various automatic control actions to be implemented on the system to meet the Minute-to-minute variation of system load in power systems.

Unit 1 - Economic Dispatch **9 Hours**

Energy Management Centers and Their Functions, Architectures, recent Developments. Characteristics of Power Generating Units and Economic Dispatch

Unit 2 - Unit Commitment **9 Hours**

Unit Commitment (Spinning Reserve, Thermal, Hydro and Fuel Constraints); Solution techniques of Unit Commitment. Generation Scheduling with Limited Energy Production Cost – Cost Models, Budgeting and Planning, Practical Considerations.

Unit 3 – Interchange Of Power And Energy **9 Hours**

Interchange of power and energy, Economic aspects, Energy Interchange with unit commitment, Power Pool, Transmission effects and Issues, Wheeling, Transaction involving non-utility Parties.

Unit 4 – Supervisory Control and Data Acquisition **9 Hours**

Introduction to Supervisory Control and Data Acquisition, SCADA Functional requirements and Components, General features, Functions and Applications, Benefits, Configurations of SCADA, RTU (Remote Terminal Units) Connections.

Unit 5 - Power Systems SCADA **9 Hours**

Power Systems SCADA and SCADA in Power System Automation, SCADA Communication requirements, SCADA Communication protocols: Past Present and Future, Structure of a SCADA communications Protocol.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Understand Energy management systems.
- Understand the various solution techniques of Unit Commitment
- Understand the regional operations of power systems.
- Understand about Supervisory control and data acquisition.
- Understand the SCADA Communications protocol

Text Books

1. Mini S.Thomos & John D.Mcdonald, "Power system SCADA and smart grids", CRC press, 2015.
2. Wood, A. J and Wollenberg, B. F, "Power Generation Operation and Control", 2nd Edition John Wiley and Sons, 2013.

References

1. Stuart A.Boyer, "SCADA: Supervisory Control and Data Acquisition", by ISA; 4th Revised Edition 2010
2. Turner, W. C, "Energy Management Handbook", Vol. 2, 8th Edition, 2010.
3.

21EEE31	Special Electrical Machines	L	T	P	C
		3	0	0	3

Course Objectives

- Construction, principle of operation, control and performance of stepping motors.
- Construction, principle of operation, control and performance of switched reluctance motors.
- Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
- Construction, principle of operation and performance of permanent magnet synchronous motors.
- Construction, principle of operation and performance of other special Machines.

Unit 1 - Stepper Motors **9 Hours**

Constructional Features-principle of operation types and torque equations-modes of excitation, characteristics, driver circuits, and microprocessor control of stepper motors, concept of lead angle, applications.

Unit 2 - Switched Reluctance Motors **9 Hours**

Constructional feature – principle of operation – torque production –Power converters and their controllers – methods of rotor position sensing sensor less operation-characteristics- closed loop control applications.

Unit 3 – Synchronous Reluctance Motors **9 Hours**

Constructional feature -Axial and Radial flux motor- operating principles-voltage and torque equation – Phasor diagram --performance characteristics -applications.

Unit 4 – Permanent Magnet Brushless DC Motors **9 Hours**

Construction - Principle of operation – Mechanical and Electronic commutations – Square wave and sine wave PMBLDC motors – Types of PMBLDC motor – Control of PMBLDC motor – Microprocessor based control – Applications.

Unit 5 - Permanent Magnet Synchronous Motors **9 Hours**

Construction - Principle of operation – EMF and torque equations – Phasor diagram – Vector Control – Self-control – Sensorless control – Microprocessor based control - Applications.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Know the operational features of stepping motor.
- Know the control strategy of switched reluctance motor.
- Understand the features of synchronous reluctance motor.
- Know the operational features of PMBLDC.
- Know the operational features of Permanent magnet synchronous machine.

Text Books

1. E.G. Janardanan, Special Electrical Machines, PHI, 2014.
2. J.Gnanavadivel, Dr.S.Muralidharan,. J.Karthikeyan, Principles of Special Electrical Machines, Anuradha Publications.

3. K. Venkataratnam, Special Electrical Machines, CRC Press, 2008

References

1. D. P. Kothari And I. J. Nagrath, Electric Machines, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 4thEdition, 2010.
2. Theodore Wildi, Electrical Machines Drives, Pearson Education, 2013.
3. R. Krishnan, ‘Permanent Magnet and Brushless DC Motors Drives’, CRC Press, New York, 2010.

21EEE32	Analysis of Electrical Machines	L	T	P	C
		3	0	0	3

Course Objectives

- To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems.
- To analyze the steady state and dynamic state operation of DC machine
- To provide the knowledge of theory of transformation of 3ϕ variables to 2ϕ variables.
- To analyze the steady state and dynamic state operation of three-phase induction machines.
- To analyze the steady state and dynamic state operation of three-phase synchronous machines

Unit 1 -Principles Of Electromagnetic Energy Conversion **9 Hours**

Magnetic circuits, permanent magnet, stored magnetic energy, co-energy – force and torque in singly and doubly excited systems – Machine windings and air gap MMF– winding inductances and voltage equations.

Unit 2 –Analysis of DC Machines **9 Hours**

Elementary DC machine and analysis of steady state operation – Voltage and torque equations – dynamic characteristics of permanent magnet and shunt DC motors – Time domain block diagrams – solution of dynamic characteristic by Laplace transformation – digital computer simulation of permanent magnet and shunt D.C. machines.

Unit 3 –Reference Frame Theory **9 Hours**

Historical background – phase transformation and Commutator transformation – transformation of variables from stationary to arbitrary reference frame – variables observed from several frames of reference.

Unit 4 – Analysis of Induction Machines **9 Hours**

Three phase induction machine, equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of dynamic performance for load torque variations – digital computer simulation.

Unit 5 – Analysis Of Synchronous Machines **9 Hours**

Three phase synchronous machine and analysis of steady state operation – voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – analysis of dynamic performance for load torque variations – Generalized theory of rotating electrical machine and Krons primitive machine.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Ability to understand the various electrical parameters in mathematical form.
- Ability to understand the different types of reference frame theories and transformation relationships.
- Ability to find the electrical machine equivalent circuit parameters and modeling of electrical machines.

Text Books

1. P S Bimbhra, “Generalized Theory of Electrical Machines”, Khanna Publishers, 2008
2. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, New Delhi, Prentice Hall of India, 2001.

References

1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley, Second Edition, 2010.
2. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, “ Electric Machinery”, Tata McGraw Hill, 5th Edition, 1992.

21EEE33	Multilevel Power Converters	L	T	P	C
		3	0	0	3

Course Objectives

- Modularity and scalability to meet any voltage level requirements,
- High efficiency, which is of significant importance for high-power applications,
- Superior harmonic performance, the size of passive filters and
- Absence of dc-link capacitors.

Unit 1 - Basics of Inverters **9 Hours**

Principles of operation of single-phase and three-phase DC-AC inverters, Space phasor and alpha-beta reference frame, Space vector modulation for three-phase inverters, Current control mode of inverters

Unit 2 - Modeling and Control of Grid-Connected Inverters **9 Hours**

Modeling of three-phase grid-connected inverters, Closed-loop control of three-phase inverters

Unit 3 – Multilevel Converters **9 Hours**

Basics of multilevel converters, Various multilevel converter topologies

Unit 4 – Modular Multilevel Converters **9 Hours**

Basics of cascaded half-bridge and full-bridge modules, Control aspects of the modular multilevel converter, Circulating current control

Unit 5 - Control of Grid-Connected Modular Multilevel Converters **9 Hours**

Control of grid-connected modular multilevel converter, Control of the MMC for High-Voltage DC (HVDC) transmission

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Understand the operation and modulation techniques of various DC-AC voltage-sourced converters (VSCs)
- Develop closed-loop control strategies for proper operation of various grid-connected VSCs under both steady-state and transient operating conditions
- Ways to recognize the salient features of the Modular Multilevel Converter (MMC) as compared with other multilevel VSCs
- The operational/control challenges associated with the MMC

Text Books

1. Grandi, Gabriele, Ruderman, Alex, Multilevel Converters: Analysis, Modulation, Topologies, and Applications, MDPI - Multidisciplinary Digital Publishing, 2019.
2. Apparao Dekka, Bin Wu, Sixing Du, Navid Zargari, Modular Multilevel Converters: Analysis, Control, and Applications , IEEE Press Series on Power and Energy Systems Hardcover, 2018

References

1. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla, Multilevel Converters for Industrial Applications, CRC Press, 2017

21EEE34	Power Quality	L	T	P	C
		3	0	0	3

Course Objectives

To impart knowledge about the following topics:

- Causes & Mitigation techniques of various PQ events.
- Various Active & Passive power filters.

Unit 1 – INTRODUCTION TO POWER QUALITY **9**

Terms and definitions & Sources – Overloading, under voltage, over voltage - Concepts of transients - Short duration variations such as interruption - Long duration variation such as sustained interruption - Sags and swells - Voltage sag - Voltage swell - Voltage imbalance – Voltage fluctuations - Power frequency variations - International standards of power quality– Computer Business Equipment Manufacturers Associations (CBEMA) curve

Unit 2 - VOLTAGE SAG AND SWELL **9**

Estimating voltage sag performance - Thevenin's equivalent source - Analysis and calculation of various faulted condition - Estimation of the sag severity - Mitigation of voltage sag, Static transfer switches and fast transfer switches. - Capacitor switching – Lightning - Ferro resonance - Mitigation of voltage swell.

Unit 3 – HARMONICS **9**

Harmonic sources from commercial and industrial loads - Locating harmonic sources – Power system response characteristics - Harmonics Vs transients. Effect of harmonics – Harmonic distortion - Voltage and current distortions - Harmonic indices - Inter harmonics – Resonance Harmonic distortion evaluation, IEEE and IEC standards.

Unit 4 – PASSIVE POWER COMPENSATORS **9**

Principle of Operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators Simulation and Performance of Passive Power Filters- Limitations of Passive Filters Parallel Resonance of Passive Filters with the Supply System and Its Mitigation. Fundamentals of load compensation – voltage regulation & power factor correction.

Unit 5 - POWER QUALITY MONITORING & CUSTOM POWER DEVICES **9**

Monitoring considerations - Monitoring and diagnostic techniques for various power quality problems - Quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters Disturbance analyzer - Applications of expert systems for power quality monitoring. Principle& Working of DSTATCOM – DSTATCOM in Voltage control mode, current control mode, DVR Structure – Rectifier supported DVR – DC Capacitor supported DVR -Unified power quality conditioner.

Total: 45

Course Outcome

- Ability to understand various sources, causes and effects of power quality issues, electrical systems and their measures and mitigation.
- Ability to analyze the causes & Mitigation techniques of various PQ events.
- Ability to study about the various Active & Passive power filters.

- Ability to understand the concepts about Voltage and current distortions, harmonics.
- Ability to analyze and design the passive filters.
- Ability to acquire knowledge on compensation techniques.
- Ability to acquire knowledge on DVR.

Text Books

1. Roger. C. Dugan, Mark. F. Mc Granagham, Surya Santoso, H.WayneBeaty, "Electrical Power Systems Quality", McGraw Hill,2003
2. J. Arrillaga, N.R. Watson, S. Chen, "Power System Quality Assessment", (New York: Wiley), 2000.
3. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad," Power Quality Problems & Mitigation Techniques" Wiley, 2015.

References

1. G.T. Heydt, "Electric Power Quality", 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994.
2. M.H.J Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", (New York: IEEE Press), 2000.

21EEE35	Power Electronics for Renewable Energy Systems	L	T	P	C
		3	0	0	3

Course Objectives

- To provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

Unit 1 - Introduction — **9 Hours**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

Unit 2 - Electrical Machines For Renewable Energy Conversion — **9 Hours**

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

Unit 3 – Power Converters — **9 Hours**

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing

Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

Unit 4 – Analysis Of Wind And PV Systems — **9 Hours**

Standalone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system

Unit 5 - Hybrid Renewable Energy Systems — **9 Hours**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Explain the operating principles and characteristics of renewable energy sources for sustainable energy conversion
- Understand the power quality issues and mitigation techniques used in grid connected systems for ensuring the quality of power
- Choose the proper power converters and inverters for harmonic reduction in solar photovoltaic systems.
- Analyze the control and protection of hybrid renewable energy systems for stable operation of power systems.

- Develop the acceptable scheme for extracting maximum power from solar photovoltaic module using maximum power point tracking algorithms.G

Text Books

1. Mukund R Patel, "Wind and Solar Power Systems", CRC Press, 1stEdition, 1999.
2. ArindamGhosh, Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices", Springer, 1st Edition, 2002.

References

1. SN Bhadra, D. Kastha, S. Banerjee, "wind electrical systems", OXFORD higher education, 2018
2. Roger C Dugan, Mark E Mc. Granaghan, Surya Santosoh and H. Wayne Beaty, "Electrical Power Systems Quality", TATA McGraw Hill, 2ndEdition, 2010.

21EEE36	Advanced Control System	L	T	P	C
		3	0	0	3

Course Objectives

- To impart in-depth knowledge in the field of control theory, analysis and design of MIMO systems in state space
- Basic understanding on features of linear and nonlinear systems
- To analyze the features of linear and nonlinear systems using phase plane analysis and
- describing function analysis
- To analyze the stability of linear and nonlinear systems using stability concepts

Unit 1– State Variable Representation **9 Hours**

Introduction, Concept of State Equation for Dynamic Systems, Non Uniqueness of State model, State Diagrams, Physical Systems and State Assignments - State space representation of multivariable systems

Unit 2 – Solution of State Equations **9 Hours**

Diagonalization, Solution of State Equations, Concepts of Controllability and Observability.

Unit 3 – Design in State Space **9 Hours**

Introduction, Stability Improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement, State Regulator Design, Design of State Observer, Compensator Design by the Separation Principle.

Unit 4 – Non Linear Systems Analysis **9 Hours**

Introduction, Common Nonlinear System Behaviours, Common Nonlinearities in Control Systems, Fundamentals, Describing Functions of Common Nonlinearities, Stability Analysis by Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane.

Unit 5 - Stability Analysis **9 Hours**

Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems.

Total: 45

Course Outcome

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

- Discuss state variable approach for linear time invariant systems in both the continuous and discrete time systems.
- Develop of state models for linear continuous – time and discrete – time systems.
- Apply vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems.
- Define controllability and observability of a system and test for controllability and observability of a given system.
- Design pole assignment and state observer using state feedback.
- Develop the describing function for the nonlinearity present to assess the stability of the system.
- Develop Lyapunov function for the stability analysis of nonlinear systems.

Text Books
1. Katsuhiko Ogata, "Modern Control Engineering ", PHI Learning Pvt Ltd, 5th Edition, 2010 2. Hassan K Khalil, "Nonlinear Control ", Pearson Prentice Hall, 1st Edition, 2014
References
1. M. Gopal, "Modern Control Systems Theory", New Age Publishers, 3rd Edition, 2014. 2. Richard C. Dorf, Robert H. Bishop, "Modern Control Systems", Prentice Hall, 12th Edition, 2010.

21EEE37	Neural Network and Fuzzy Control	L	T	P	C
		3	0	0	3

Course Objectives

- Apply the design concepts of feed forward and feedback neural networks for solving Engineering problems
- Select appropriate weight and learning constant values for every learning
- Formulate and analyze the real time system with the knowledge of fuzzy logic control
- Provide adequate knowledge of application of fuzzy logic control to real time systems.

Unit 1 - Introduction to Artificial Neural Network **9 Hours**

Artificial neural networks and their biological motivation – Terminology – Models of neuron – Topology – Characteristics of artificial neural networks – Types of activation functions. Learning Laws: Learning methods – Error correction learning – Hebbian learning – Perceptron – XOR problem – Perceptron learning rule convergence theorem – Adaline – Madaline

Unit 2 – Feedforward and Recurrent Neural Networks **9 Hours**

Multilayer Perceptron – Delta Learning – Back Propagation learning algorithm – Universal function approximation – Associative memory: auto association and hetero association. Bi-directional associative memory – Hopfield neural network – Travelling Salesman Problem.

Unit 3 – Fuzzy Systems **9 Hours**

Classical sets – Fuzzy sets – Fuzzy relations – Fuzzification – Defuzzification – Fuzzy rules.

Unit 4 – Fuzzy Logic Control **9 Hours**

Membership function – Knowledge base – Decision-making logic – Optimisation of membership function using neural networks – Adaptive fuzzy system – Introduction to genetic algorithm.

Unit 5 - Applications of FLC **9 Hours**

Fuzzy logic control – Inverted pendulum – Image processing – Home heating system – Blood pressure during anesthesia – Introduction to neuro fuzzy controller.

Total: 45

Course Outcome

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

- Design the mathematical model of a neuron and train Perceptron and Madaline for real time systems.
- Explore the concepts of Recurrent and feedback networks
- Design of fuzzy systems for non-linear simulation with extension principle.
- Calculate the membership values with suitable Defuzzification method and the neuro-fuzzy inference systems concept to modern controllers.
- Design a component or a product applying all the relevant standards with realistic Constraints

Text Books

1. Ross, Timothy J. Fuzzy logic with engineering applications. John Wiley & Sons, 2009.
2. Yegnanarayana, B. Artificial neural networks. PHI Learning Pvt. Ltd., 2004.

References
1. Laurene Fausett, Fundamentals of Neural Networks – Architectures, algorithms and applications, Pearson Education Inc., 2004 2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, John Wiley and sons, 2 017 3. Simon Haykin, Neural Networks and learning Machines", Mac Millen College Pubco.,ew York, 2016.

21EEE38	Bio-Medical Instrumentation	L	T	P	C
		3	0	0	3

Course Objectives

- Introduce Fundamentals of Biomedical Engineering
- Study the communication mechanics in a biomedical system with few examples
- Study measurement of certain important electrical and non-electrical parameters
- Understand the basic principles in imaging techniques
- Basic knowledge in life assisting and therapeutic devices

Unit 1 - Introduction **9 Hours**

Sources of bioelectric potentials, cardiovascular system, Central nervous system, Muscular System, linear/nonlinear analysis of different physiological signals (ECG, EEG, EMG), Electrode theory - mathematical analysis including Nernst equation, Goldman equation, Electrical conductivity of electrode, Electrodes for ECG, EEG &EMG.

Unit 2 – General Considerations of Medical Instruments **9 Hours**

Operational Amplifiers, Bioelectric Amplifiers, Selection of biomedical amplifiers – Isolation amplifiers, Charge amplifiers and Chopper amplifier. Characteristics of biomedical recorder amplifiers, Physiological effects of electric currents, Electric shock hazards and leakage currents, Methods of accident prevention.

Unit 3 – Diagnostic & Therapeutic Equipments9 Hours

ECG Lead Configuration, Vector cardiograph, Phono-cardiograph, EEG and EMG Electrode system, Recorders, Measurement of various volumes/capacity of lungs, Spirometer. Measurement of cardiac output, blood flow and blood pressure.
Cardiac pacemakers, cardiac defibrillators, nerve & muscle stimulators, diathermy-types, ventilators, Dialyzer.

Unit 4 – Medical Laboratory Instrumentation & Measurement **9 Hours**

Analysis of Blood-Measurement of pH, pO2 and pCO2 value of blood using pH/gas analyzers. Photometers, Haematology, Blood cell counters, Electrophoresis- Serum detection and classification, Blood Glucose Sensors, GSR measurements.

Unit 5 - Advanced Diagnostic Techniques **9 Hours**

2D, 3D Analysis and Visualization (X-Ray, MRI, CT), Biomedical Spectroscopy, Optical coherence tomography, Fluorescence based Bio-detection & Bio-imaging- Case study: Telemedicine based health care monitoring system.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Evaluate and analyse the different physiological signals
- Relate the knowledge to select appropriate medical instruments
- Design and maintain the bio electric devices used for diagnostic and therapeutic equipment
- Create and understand the procedure in analysis of Blood used in medical laboratory
- Use the knowledge to differentiate the advanced diagnostic techniques.

Text Books

1. Leslie Cromwell, Fred J, Weibell & Erich A and P Feiffer, 'Biomedical Instrumentation and Measurements', 2nd Edition, PHI, 2011.
2. Joseph J Carr and John M.Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th edition, 2012

3. M.Arumugam, ‘Bio-Medical Instrumentation’, Anuradha Agencies, 2003.

References

1. R. S. Khandpur, ‘Handbook of Biomedical Instrumentation’, Tata Mc-Graw Hill, 2nd edition, 2014
2. John.E. Hall, Guyton and Hall, Textbook of Medical Physiology, Saunders; 13th Edition, 2015
3. Rangaraj M. Rangayyan, ‘Biomedical Signal Analysis’, A Case-Study Approach, Wiley, 2nd Edition, 2015.

21EEE39	High Voltage Engineering	L	T	P	C
		3	0	0	3

Course Objectives

- Various types of over voltages in power system and protection methods.
- Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
- Generation of over voltages in laboratories.
- Measurement of over voltages.
- Testing of power apparatus and insulation coordination

Unit 1 - High voltages in electrical systems **9 Hours**

Levels of High voltage – Natural causes for over voltages – lightning switching and temporary over voltage – Protection against over voltage – bewley's lattice diagram - Surge voltage and their distribution and control.

Unit 2 - Dielectric Breakdown **9 Hours**

Properties of Dielectric materials – Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipments.

Unit 3 – Generations of high voltages and currents **9 Hours**

Generations of high direct current and alternating voltages – generation of impulse voltages and currents – tripping and control of impulse generators.

Unit 4 – Measurement of high voltages and currents **9 Hours**

Measurement of high direct current voltages - Measurement of high ac and impulse voltages - Measurement of high current – direct, alternating and impulse – cathode ray oscillographs for impulse voltage and current measurements – measurement of direct current resistivity – measurement of dielectric constant and loss factor - partial discharge measurement.

Unit 5 - High Voltage Testing & Insulation Coordination **9 Hours**

Testing of insulators and bushings - Testing of isolators and circuit breakers - Testing of cables - Testing of transformers - Testing of surge arrestors – radio interference measurements. Principles of insulation coordination on high voltage and extra high voltage power system.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Derive and analyze the expression of current growth and breakdown voltage due to various mechanisms of gaseous breakdown in dielectrics/ insulation
- Derive and analyze the various mechanisms of breakdown in liquid and solid dielectrics breakdown
- Identify the various methodologies for high voltage and high current generation
- Analyze the various types of high voltage and high current measurement techniques
- Evaluate the impact of various insulation tests of electrical power apparatus

Text Books

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 5rd Edition, 2013.

2. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition, 2000.

References

4. Extra High Voltage AC Transmission Engineering , Rakosh Das Begamudre, New Age
International (P) Ltd., New Delhi – 2007.
5. High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 2010.
6. High Voltage Engineering:, E. Kuffel, W. S. Zaengl, J. Kuffel, Cbs Publishers New Delhi, 2nd Edition, 2005.

21EEE40	Machine Monitoring System	L	T	P	C
		3	0	0	3

Course Objectives

- To know the requirement of regular monitoring and heath assessment of various electrical drives, transformers, circuit breakers and other equipment.
- To understand the techniques available for monitoring and heath assessment
- Enable the students to understand the concepts, principles and acquire basic skills of condition monitoring and diagnostics of electrical equipments in power stations, substations and industry.

Unit 1 - Maintenance and Condition Monitoring **9 Hours**

Importance and necessity of maintenance, different maintenance strategies like Breakdown maintenance, planned maintenance and condition based maintenance. Planned and preventive maintenance of transformer, induction motor and alternators. Insulation stressing factors, insulation deterioration, polarization index, dielectric absorption ratio. Insulation ageing mechanisms, Insulation failure modes, Definition of terms, Concept of condition monitoring of electrical equipments. Overview of Advanced tools and techniques of condition monitoring, Condition monitoring by thermography.

Unit 2 - Transformer Diagnostics Technique **9 Hours**

Introduction, Transformer failure pattern and failure analysis, Aging of electrical Power infrastructure, Diagnostic method, Transformer oil paper insulation system, Remaining life analysis, Gas Evolution in a Transformer, Partial Discharge measurements, PD Measuring circuits, calibration, signature analysis, Indirect electrical measurement, UHF sensor and HF CT, Measurement of PD under DC, Acoustic Technique, Evolution, Principle, OLTC and Bushing diagnostics, Accessories, Life Assessment and Refurbishment

Unit 3 – Monitoring of Rotating Electrical Machines **9 Hours**

Need for monitoring, Construction, operation and failure modes of electrical machines, Structure of electrical machines and their types, Machine specification and failure modes, Failure sequence and effect on monitoring, Typical root causes and failure modes, General, Root causes, Failure modes.

Unit 4 – Temperature & Chemical monitoring **9 Hours**

Instrumentation requirement for Temperature measurement, Local temperature measurement, Hot-spot measurement and thermal images, Bulk measurement. Insulation degradation, Factors that affect detection, Insulation degradation detection, Particulate detection: core monitors, Particulate detection: chemical analysis, Gas analysis off-line, Gas analysis on-line, Lubrication oil and bearing degradation.

Unit 5 - Vibration monitoring **9 Hours**

Instrument required for Vibration measurement, Condition monitoring of rotating elements, Bearing response, Rolling element bearings, bearing geography, Bearing Monitoring techniques, Overall level monitoring, Frequency spectrum monitoring.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Assess the condition of various electrical installation based on Insulation status.
- Implement condition monitoring plan for complete Electrical System
- Identify amount of damage/deterioration in the Equipment
- Check the mechanical integrity of the equipment

Text Books

1. Hamid A Toliyat, Subhasis Nandi, Seungdeog Choi, HomayounMeshgin-Kelk, " Electric Machines: Modeling, Condition Monitoring and Fault Diagnostics, CRC Press
2. Chakravorti Sivaji, DeyDebangshu, Chatterjee Biswendu, "Recent Trends in the Condition
3. Monitoring of Transformers- Theory, Implementation and Analysis" Springer, 2013G

References

1. W. H. Tang and Q. H. Wu, "Condition Monitoring and Assessment of Power Transformers Using computation Intelligence", Springer, London 2010
2. Peter Tavner, Li Ran, Jim Penmanand Howard Sedding, "Condition Monitoring of Rotating Electrical Machines", Published by The Institution of Engineering and Technology, London, United Kingdom, 2008

21EEE41	Green Energy Systems	L	T	P	C
		3	0	0	3

Course Objectives

- To demonstrate the importance of solar energy collection and storage.
- To understand the principles of wind energy and biomass energy.
- To gain knowledge on geothermal and ocean energy.
- To acquire knowledge about energy efficient systems.
- To understand the concepts of green manufacturing systems.

Unit 1 – Solar Energy **9 Hours**

Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.

Unit 2 –Wind Energy **9 Hours**

Power in the Wind – Types of Wind Power Plants(WPPs)–Components of WPPs-Working of WPPs- Siting of WPPs-Grid integration issues of WPPs.

Unit 2 – Bio-Mass Energy **9 Hours**

Introduction-Bio mass resources –Energy from Bio mass: conversion processes-Biomass Cogeneration-Environmental Benefits.

Unit 4 – Geothermal & Ocean Energy **9 Hours**

Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

Unit 5 – Introduction to Fuel Cells **9 Hours**

Introduction – working and types of fuel cell – low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell solid oxide, hydrogen fuel cells – thermodynamics and electrochemical kinetics of fuel cells, Energy Storage System- Hybrid Energy Systems.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Obtain knowledge of different types of renewable energy sources.
- Obtain the solar energy geometry and characteristics of different type's thermal collectors and PV cells and related applications.
- Understand the types, performance, integration of wind mill and its applications.
- Understand the working principles of geothermal energy and its application along with estimation.
- Obtain the basic knowledge of biomass energy conversion techniques
- Understand the fuel cells types, working principles and its related applications.

Text Books

1. Frank Kreith, Susan Krumdeick, Principles of Sustainable Energy Systems, CRC press, Taylor and Francis group, Second Edition, 2014
2. G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 2004.

References

1. John Twidell and Tony Weir, Renewable Energy Resources, Second edition, Taylor & Francis, 2006.
2. G.D. Rai, Solar Energy Utilizations, Khanna Publishers, Second Revised Edition, 2004
3. Putnam, Energy from the Wind, Prentice Hall of India.2004

21EEE42	Smart Grid	L	T	P	C
		3	0	0	3

Course Objectives

- Architecture designs
- Measurement and Communications Technologies
- Smart Grid technologies, different smart meters and advanced metering infrastructure.
- Power quality management issues in Smart Grid.
- High performance computing for Smart Grid applications.

Unit 1 -Smart Grid Architectural Designs 9 Hours

Introduction. Evolution of electric Grid, Need for smart grid, difference between Conventional grid and smart grid, General View of the Smart Grid Market Drivers, Functions of Smart Grid Components, present development and international policies in smart grid.

Unit 2 - Smart Grid Communications And Measurement Technology 9 Hours

Communication and Measurement , Monitoring, PMU, Smart Meters, and Measurements Technologies ,Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) , Smart Meters , Smart Appliances, Advanced Metering Infrastructure (AMI),, GIS and Google Mapping Tools Multi agent Systems (MAS) Technology ,Multi agent Systems for Smart Grid Implementation , Micro grid and Smart Grid Comparison

Unit 3 –Performance Analysis Tools For Smart Grid Design 9 Hours

Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, types, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, Cases for the Development of Stochastic Dynamic optimal Power Flow (DSOPF), Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingency Studies for the Smart Grid

Unit 4 – Information Security And Communication Technology For Smart Grid 9 Hours

Data communication, switching techniques, communication channels, HAN, NAN, WAN, Bluetooth, Zigbee, GPS, Wi-Fibased communication, Wireless mesh network, Basic of cloud computing and cyber security for smart grid, Broadband over power line(BPL)

Unit 5 -Power Quality Management In Smart Grid 9 Hours

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Describe the necessity and evolution of smart grid with policies
- Identify the apt choice for measuring the data by applying various technology
- Acquire knowledge about different smart meters and advanced metering infrastructure.
- Acquire knowledge on power quality management in Smart Grids.
- Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

Text Books
1. Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRC Press2012. 2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihi kookoyam "Smart Grid: Technologyand Applications", John Wiley sons inc,2012
References
1. Fereidoon P.Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012 2. James Momohe "Smart Grid: Fundamentals of Design and Analysis,", Wiley-IEEE Press, 2012.

21EEE43	Power System Transients	L	T	P	C
		3	0	0	3

Course Objectives

- Generation of switching transients and their control using circuit – theoretical concept.
- Mechanism of lighting strokes and the production of lighting surges.
- Propagation, reflection and refraction of travelling waves.
- Voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

Unit 1 -Introduction to Transients **9 Hours**

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

Unit 2 – Switching Transients **9 Hours**

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

Unit 3 –Lightning Transients **9 Hours**

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

Unit 4 – Traveling wave concept **9 Hours**

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

Unit 5 - Transients In Integrated Power System **9 Hours**

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

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Understand and analyze switching and lightning transients.
- Acquire knowledge on generation of switching transients and their control.
- Analyze the mechanism of lighting strokes.
- Understand the importance of propagation, reflection and refraction of travelling waves.
- Analyze the voltage transients caused by faults, concept of circuit breaker action, load rejection on integrated power system.

Text Books
1. Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Inter Science, New York, 2ndEdition, 1991. 2. C.S. Indulkar, D.P.Kothari, K. Ramalingam, 'Power System Transients – A statistical approach', PHI Learning Private Limited, Second Edition, 2010.
References
1. Pribindra Chowdhuri, "Electromagnetic transients in power systems", Pearson Education Limited, 2004 2. J.L.Kirtley, "Electric Power Principles, Sources, Conversion, Distribution and use," Wiley, 2012. 3. Akihiro ametani," Power System Transient theory and applications", CRC press, 2013.

21EEE44	Energy Storage Systems	L	T	P	C
		3	0	0	3

Course Objectives

- Understand the necessity and usage of different energy storage schemes for different purposes
- Have a technological overview of various energy storage schemes
- Understand the operational mechanisms of each energy storage system
- Be able to characterize and analyze electrochemical energy storages

Unit 1 -Energy Storage Methods **9 Hours**

Need for Energy storage-Different energy storage Methods- Mechanical energy storage: Pumped storage, Compressed air storage - Electromagnetic storage Electrostatic storage-Thermal energy storage: Sensible heat storage, Latent heat storage-Different methods of chemical Energy storage-Reversible Chemical Storage.

Unit 2 - Hydrogen Energy Storage Systems **9 Hours**

Block diagram of Hydrogen energy systems - Properties of Hydrogen – Extraction methods of Hydrogen: Thermochemical methods - Electrolysis of water – Thermolysis of water- Bio photolysis - Hydrogen storage techniques Delivery of Hydrogen Conversion of Hydrogen - Applications-Safety Issues.

Unit 3 –Energy Storage Using Batteries **9 Hours**

Batteries - Construction and working - Elements of electrochemical cell-operation of electrochemical cell Theoretical cell voltage and capacity-Losses in a cell-Battery classification-Constructions and working principle of Lead Acid battery-Nickel Cadmium batteries-Lithium-ion batteries-Battery parameters: Battery capacity, Battery Voltage, Depth of discharge-Battery life cycle-Discharge/charge rate, Selfdischarge - Ragone Plots.

Unit 4 – Battery Charging And Charge Controllers **9 Hours**

Factors affecting battery performance: Battery voltage level, Battery Discharge current, Battery Temperature during discharge-Factors affecting Choice of a battery charging and discharging methods-Charge controllers for stand-alone PV system-Types of charge controllers for stand-alone PV system: Shunt type, Series type, DC-DC converter type, MPPT charge controller – Power stage and control scheme for battery charging using DC-DC converter-Flow chart for battery charging.

Unit 5 -Fuel Cell **9 Hours**

Introduction-Advantages-Applications-Classification of fuel cells- Construction and working of Phosphoric Acid fuel cell-Alkaline Fuel cell-Polymer Electrolyte Membrane Fuel cell-Fuels for Fuel Cells-Efficiency of Fuel cell-VI characteristics of Fuel Cell-Power Electronics controller for fuel cell .

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Apply engineering fundamentals to design and implement alternate energy storage technologies
- Understand the principles behind the hydrogen storage
- Understand knowledge on various kinds of batteries
- Acquire knowledge on battery charging and charge controller
- Fabricate and investigate the performance of selected energy storage solutions

Text Books
1. Ter-Gazarian, A.G.Energy Storage for Power Systems, 2nd Edition, IET Publications, 2011 2. Chetan Singh Solanki., "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2nd Edition, 2012.
References
1. Robert A. Huggins, "Energy Storage", Springer Science & Business Media, 2010.

21EEE45	Electric Vehicle	L	T	P	C
		3	0	0	3

Course Objectives

- Introduces the fundamental concepts, principles, analysis and design of hybrid electric vehicles

Unit 1 - Introduction to Conventional & Electric Vehicles — 9 Hours

Conventional Vehicle: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.
Electric Vehicle: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, future of electric vehicles, comparison with IC engine drive vehicles

Unit 2 - Electric Vehicle Drive Train — 9 Hours

Transmission configuration, Components, gears, differential, clutch, brakes, regenerative braking, motor sizing. Basic concept of electric traction, Introduction to various drive train topologies, power flow control in electric drive topologies, fuel efficiency analysis

Unit 3 – Electric Propulsion Unit — 9 Hours

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

Unit 4 – Energy Storage — 9 Hours

Introduction to energy storage requirements in hybrid and Electric vehicles, Battery based energy storage and its analysis, fuel cell based and super capacitor based energy storage and its analysis. Hybridization of different energy storage devices

Unit 5 - Energy management strategies — 9 Hours

Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies - Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Total: 45

Course Outcome

On the completion of this course the student will be able to:

- Understand the functional concepts of vehicles.
- Describe the performance of hybrid electric vehicles.
- Study of Electric trains.
- Understand the different possible ways of energy storage.
- Understand the various strategies in energy storage system.

Text Books

1. Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, Second Edition, 2011.
2. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010

References
1. Chris Mi, MA Masrur, and D W Gao, "Hybrid Electric Vehicles- Principles and Applications with Practical Perspectives", Wiley, 2011. 2. Davide Andrea, "Battery management Systems for Large Lithium-Ion Battery Packs", Artech House, 2010.