DEPARTMENT OF
ELECTRICAL & ELECTRONICS ENGINEERING

COURSE STRUCTURE AND SYLLABUS
For PG –R22
M. TECH – POWER SYSTEMS
(Applicable for batches admitted from 2022-2023)

St. ANN'S COLLEGE OF ENGINEERING & TECHNOLOGY
(AUTONOMOUS)
CHIRALA – 523187, ANDHRA PRADESH, INDIA

(Accredited by NBA, NAAC with 'A' Grade, accredited by IE (I) & Permanently Affiliated to JNTUK)
Recognized by UGC under Section 2(f) & 12(B) of UGC Act

SEMESTER I

S. No	Category	Course Code	Course Title	Theory/ Lecture (L)	Tutorial (T)	Practical/ Drawing (P)	Self-Study (SS)	Duration in hours/ Week	CIE Marks	SEE Marks	Total Marks	Credits
1	PC	22PPS01	Power System Operation & Control	3	--	--	--	3	40	60	100	3
2	PC	22PPS02	Hybrid Electric Vehicles	3	--	--	--	3	40	60	100	3
3	PE	22PPS03	Electrical Distribution Automation	3	--	--	--	3	40	60	100	3
		22PPS04	Renewable Energy Technologies									
		22PPS05	Power System Deregulation									
4	PE	22PPS06	HVDC Transmission	3	--	--	--	3	40	60	100	3
		22PPS07	Advanced Power Systems Protection									
		22PPS08	Power System Reliability									
5	CC	22PPS09	Research Methodology and IPR	--	--	--	--	--	40	60	100	2
6	PC	22PPS10	Power System Simulation Laboratory - I	--	--	4	--	4	40	60	100	2
7	PC	22PPS11	Power Systems Laboratory	--	--	4	--	4	40	60	100	2
8	MC	--	Audit Course-1*	2	--	--	--	2	40	60	100	0
Total				14	0	8	0	22	320	480	800	18

HS-Humanities & Sciences, BS-Basic Sciences, ES-Engineering Sciences, MC-Mandatory Course (*Student has to choose any one audit course listed below.), PC-Professional Core, PE-Professional Elective, OE-Open, Elective, PR – Internship / Project

Audit Course 1 & 2:

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills

SEMESTER II

S. NO	Category	Course Code	Course Title	Theory/ Lecture (L)	Tutorial (T)	Practical/ Drawing (P)	Self-Study (SS)	Duration in hours/ Week	CIE Marks	SEE Marks	Total Marks	Credits
1	PC	22PPS13	Power System Dynamics and Stability	3	--	--	--	3	40	60	100	3
2	PC	22PPS14	Flexible AC Transmission Systems	3	--	--	--	3	40	60	100	3
3	PE	22PPS15	EHVAC Transmission	3	--	--	--	3	40	60	100	3
		22PPS16	Real Time Control of Power Systems									
		22PPS17	Analysis of Power Electronic Converters									
4	PE	22PPS18	Generation & Measurement of High Voltages	3	--	--	--	3	40	60	100	3
		22PPS19	Evolutionary Algorithms and Applications									
		22PPS20	Programmable Logic Controllers & Applications									
5	PC	22PPS21	Power System Simulation Laboratory - II	--	--	4	--	4	40	60	100	2
6	PC	22PPS22	Power Converters Laboratory	--	--	4	--	4	40	60	100	2
7	PR	22PPS23	Mini Project with Seminar	--	--	4	--	4	100	--	100	2
8	MC	---	Audit Course-2*	2	--	--	--	2	40	60	100	0
Total				14	0	12	0	26	380	420	800	18

HS-Humanities & Sciences, BS-Basic Sciences, ES-Engineering Sciences, MC-Mandatory Course (*Student has to choose any one audit course listed below.), PC-Professional Core, PE-Professional Elective, OE-Open, Elective, PR – Internship / Project

Audit Course 1 & 2:

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills

SEMESTER III

S. No	Category	Course Code	Course Title	Theory/ Lecture (L)	Tutorial (T)	Practical / Drawing (P)	Self-Study (SS)	Duration in hours/ Week	CIE Marks	SEE Marks	Total Marks	Credits
1	PE	22PPS25	Energy Audit Conservation &Management	3	--	--	--	3	40	60	100	3
		22PPS26	Smart Grid Technologies									
		22PPS27	Power Quality And Custom Power devices									
2	OE	22PPS28	Industrial Safety	3	--	--	--	3	40	60	100	3
		22PPS29	Artificial Intelligent Techniques									
		22PPS30	Operations Research									
3	PR	22PPS31	Dissertation-I/ Industrial Project	---	--	20	--	20	--	100	100	10
Total				6	0	20	0	26	80	220	300	16

HS-Humanities & Sciences, BS-Basic Sciences, ES-Engineering Sciences, MC-Mandatory Course (*Student has to choose any one audit course listed below.), PC-Professional Core, PE-Professional Elective, OE-Open, Elective, PR – Internship / Project
**Students going for Industrial Project/Thesis will complete these courses through MOOCs

SEMESTER IV

S. No	Category	Course Code	Course Title	Theory/ Lecture (L)	Tutorial (T)	Practical/ Drawing (P)	Self-Study (SS)	Duration in hours/ Week	CIE Marks	SEE Marks	Total Marks	Credits
1	PR	22PPS32	Dissertation-II	---	---	32	--	32	---	100	100	16
Total				0	0	32	0	32	0	100	100	16

HS-Humanities & Sciences, BS-Basic Sciences, ES-Engineering Sciences, MC-Mandatory Course (*Student has to choose any one audit course listed below.), PC-Professional Core, PE-Professional Elective, OE-Open, Elective, PR – Internship / Project

Total Credits =68

I Year - I Semester	22PPS01	L	T	P	C
		3	0	0	3

Power System Operation & Control

Pre-requisite: Knowledge on Power Generation Engineering, Power Transmission Engineering.

Course Educational Objectives:

- To study the unit commitment problem for economic load dispatch.
- To study the load frequency control of single area and two area systems with and without control.
- To study the effect of generation with limited energy supply.
- To study the effectiveness of interchange evaluation in interconnected power systems.

UNIT – 1

Unit commitment problem and optimal power flow solution: Unit commitment: Constraints in UCP,UC solution methods. Priority list method, introduction to Dynamic programming Approach.

Optimal power flow: OPF without inequality constraints, inequality constraints on control variables and dependent variables.

UNIT – 2

Single area Load Frequency Control: Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response.

UNIT – 3

Two area Load Frequency Control: Load frequency control of two-area system, uncontrolled case and controlled case, tie-line bias control, steady state representation. Optimal two-area LF control- performance Index and optimal parameter adjustment. Load frequency control and Economic dispatch control.

UNIT – 4

Generation with limited Energy supply : Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, Hard limits and slack variables, Fuel scheduling by linear programming.

UNIT – 5

Interchange Evaluation and Power Pools Economy Interchange: Economy interchange Evaluation, Interchange Evaluation with unit commitment, Multiple Interchange transactions, Other types of Interchange, power pools, transmission effects and issues.

Course Outcomes: At the end of the course, student will be able to

- Determine the unit commitment problem for economic load dispatch.
- Get the knowledge of load frequency control of single area system with and without control.
- Get the knowledge of load frequency control of two area system with and without control.
- Know the effect of generation with limited energy supply.
- Determine the interchange evaluation in interconnected power systems.

Text Books:

1. Power Generation, Operation and Control - by A.J.WoodandF.Wollenberg,Johnwiley& sons Inc. 1984.
2. Modern Power System Analysis - by I.J.Nagrath&D.P.Kothari, Tata McGraw-Hill Publishing Company ltd, 2nd edition.

Reference Books:

1 Power system operation and control PSR Murthy B.S publication.
2 Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
3 Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

I Year - I Semester	22PPS02	L	T	P	C
		3	0	0	3

Hybrid Electric Vehicles

Pre-Requisite: Power Electronics.

Course Educational Objectives:

- To understand the control principle of ac to ac conversion with suitable power semi - conductor devices.
- To have the knowledge of ac to dc conversion and different ac to dc converter topologies.
- To understand the effect of operation of controlled rectifiers on p.f. and improvement of p.f. with PFC converters
- To acquire the knowledge on dc-ac converters and to know the different control techniques of dc-ac converters.
- To know multilevel inverter configuration to improve the quality of the inverter output voltage.

UNIT– 1

Overview of Switching Devices:

Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices.

UNIT– 2

AC-DC converters: Single phase fully controlled converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters.

UNIT– 3

Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

UNIT– 4

PWM Inverters: Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques- Three phase current source inverters-Variable dc link inverter.

UNIT– 5

Multi level inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters.

Course Outcomes: At the end of the course, student will be able to

- Describe and analyze the operation of AC-DC converters.
- Analyze the operation of power factor correction converters.
- Analyze the operation of three phase inverters with PWM control.
- Study the principles of operation of multi- level inverters and their applications.

Text Books

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
2. Daniel W. Hart - McGraw-Hill,2011.

Reference Books:

1. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
2. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.

I Year - I Semester	22PPS03	L	T	P	C
		3	0	0	3

Electrical Distribution Automation
Elective - I

Pre-requisite: Knowledge on basics of distribution systems, Compensation in electrical distribution systems, Circuit Analysis, concept of load modelling.

Course Educational Objectives:

- To learn the importance of economic distribution of electrical energy.
- To analyse the distribution networks for V-drops, P_{Loss}calculations and reactive power.
- To understand the co-ordination of protection devices.
- To impart knowledge of capacitive compensation/voltage control.
- To understand the principles of voltage control.

UNIT – 1

General : Introduction to Distribution systems, an overview of the role of computers in distribution system planning-Load modelling and characteristics - definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

UNIT – 2

Distribution Feeders and Substations: Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, and feeder-loading. Design practice of the secondary distribution system. Location of Substations: Rating of a Distribution Substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations.

UNIT – 3

Protective devices and coordination: Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices: General coordination procedure; types of coordination.

UNIT – 4

Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), power factor correction, capacitor location. Economic justification. Procedure to determine the best capacitor location. Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

UNIT – 5

Distribution automation functions: Electrical system automation, EMS functional scope, DMS functional scope functionality of DMS- Steady state and dynamic performance improvement; Geographic information systems-AM/FM functions and Database management; communication options, supervisory control and data acquisition: SCADA functions and system architecture;Synchrophasors and its application in power systems.

Course Outcomes: At the end of the course, student will be able to

- Analyse a distribution system.
- Design equipment for distribution system and sub-stations.
- Design protective systems and co-ordinate the devices.
- Understand of capacitive compensation.
- Understand of distribution automation.

Text Books:

1. "Electric Power Distribution System Engineering " by Turan Gonen, McGraw-Hill Book Company,1986.
2. Distribution System Analysis and Automation, by Juan M. Gers, The Institution of Engineering and Technology, UK 2014.

Reference Books:

1. Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4thedition, 1997.
2. Electrical Distribution V.Kamaraju-McGraw Hill
3. Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press

I Year - I Semester	22PPS04	L	T	P	C
		3	0	0	3

Renewable Energy Technologies (Elective – I)

Pre requisite: UG power Electronics.

Course Educational Objectives:

- To learn the technical challenges in renewable energy.
- To learn the basics of wind energy conversion & PV power generation.
- To learn the analysis of fuel cell system.

UNIT– 1

Introduction: Renewable Sources of Energy; Distributed Generation; Renewable Energy Economics - Calculation of Electricity Generation Costs; Demand-Side Management Options; Supply-Side Management Options; Control of renewable energy based power Systems

UNIT– 2

Induction Generators: Principles of Operation; Representation of Steady-State Operation; Power and Losses Generated - Self-Excited Induction Generator; Magnetizing Curves and Self-Excitation - Mathematical Description of the Self-Excitation Process; Interconnected and Stand-alone operation - Speed and Voltage Control.

UNIT– 3

Wind Power Plants: Site Selection; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generation- General Classification of Wind Turbines; Rotor Turbines; Multiple-Blade Turbines; Drag Turbines; Lifting Turbines - Generators and Speed Control Used in Wind Power Energy; Analysis of Small wind energy conversion system.

UNIT– 4

Photovoltaic Power Plants: Solar Energy; Generation of Electricity by Photovoltaic Effect; Dependence of a PV Cell on Temperature and irradiance input-output Characteristics - Equivalent Models and Parameters for Photovoltaic Panels; MPPT schemes: P&O,INC, effect of partial shaded condition. Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy

UNIT– 5

Fuel Cells: The Fuel Cell; Low- and High-Temperature Fuel Cells; Commercial and Manufacturing Issues - Constructional Features of Proton Exchange-Membrane Fuel Cells; Reformers; Electrolyser Systems; Advantages and Disadvantages of Fuel Cells - Fuel Cell Equivalent Circuit; Practical Determination of the Equivalent Model Parameters; Aspects of Hydrogen for storage

Course Outcomes: At the end of the course, student will be able to

- Understand various general aspects of renewable energy systems.
- Analyze and design induction generator for power generation from wind.
- Design MPPT controller for solar power utilization.
- Utilize fuel cell systems for power generation.

Text Books:

1. Felix A. Farret, M. Godoy Simo` es, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

Reference Books:

1. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.

I Year - I Semester	22PPS05	L	T	P	C
		3	0	0	3

Power System Deregulation

Pre-requisite: Knowledge on power systems.

Course Educational Objectives:

- To provide in-depth understanding of operation of deregulated electricity market systems.
- To examine typical issues in electricity markets and how these are handled world –wide in various markets.
- To enable students to analyze various types of electricity market operational and control issues using new mathematical models.

UNIT – 1

Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts:marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation.

UNIT – 2

Electricity sector structures and Ownership /management, the forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

UNIT – 3

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices

UNIT – 4

Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing. Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices

UNIT – 5

Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Course Outcomes: At the end of the course, student will be able to

- Understand of operation of deregulated electricity market systems
- Typical issues in electricity markets
- Analyse various types of electricity market operational and control issues using new mathematical models.
- Understand LMP's wheeling transactions and congestion management.
- Analyse impact of ancillary services.

Text Books:

1. Power System Economics: Designing markets for electricity - S. Stoft, wiley.
2. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer.

Reference Books:

1. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.
2. Market operations in electric power systems - M. Shahidehpour, H. Yaminand Z. Li,Wiley.
3. Fundamentals of power system economics - S. Kirschen and G. Strbac, Wiley.
4. Optimization principles: Practical Applications to the Operation and Marketsof the Electric Power Industry - N. S. Rau, IEEE Press series on Power Engineeirng.
5. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth

I Year - I Semester	22PPS06	L	T	P	C
		3	0	0	3

HVDC Transmission
(Elective – II)

Pre-requisite: Knowledge on Power Electronics, Power Systems and High Voltage Engineering.

Course Educational Objectives:

- To learn various schemes of HVDC transmission.
- To learn about the basic HVDC transmission equipment.
- To learn the control of HVDC systems.
- To be exposed to the interaction between HVAC and HVDC system.
- To be exposed to the various protection schemes of HVDC engineering.

UNIT – 1

Limitation of EHV AC Transmission, Advantages of HVDC: Technical economical and reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose

UNIT – 2

Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the performance of diametrical connection with 6-pulse bridge circuit

UNIT – 3

Control of HVDC Converters and systems: constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current, harmonics effect of variation of α and μ. Filters, Harmonic elimination.

UNIT – 4

Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

UNIT – 5

Transient over voltages in HV DC systems: Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

Course Outcomes: At the end of the course, student will be able to

- Understand the various schemes of HVDC transmission.
- Understand the basic HVDC transmission equipment.
- Understand the control of HVDC systems.
- Understand the interaction between HVAC and HVDC system.
- Understand the various protection schemes of HVDC engineering.
- Understand the various schemes of HVDC transmission.

Text Books:

1. S Kamakshaih and V Kamaraju: HVDC Transmission- MG hill.
2. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.

Reference Books:

1. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
2. J.Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983
3. Vijay K Sood: HVDC and FACTS controllers:Applications of static converters in power systems by, Kluwer Academic Press.

I Year - I Semester	22PPS07	L	T	P	C
		3	0	0	3

Advanced Power Systems Protection
(Elective – II)

Pre-requisite: Concepts of Power Electronics, Electronic circuits, STLD and basics of Relays and protection.

Course Educational Objectives:

- To learn about classification and operation of static relays.
- To understand the basic principles and application of comparators.
- To learn about static version of different types of relays.
- To understand about numerical protection techniques.

UNIT – 1

Static Relays classification and Tools : Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

UNIT – 2

Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.

Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

UNIT – 3

Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings,

UNIT – 4

PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

UNIT – 5

Microprocessor based relays and Numerical Protection: Introduction – over current relays – impedance relay – directional relay – reactance relay.

Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mann-morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.

Course Outcomes: At the end of the course, student will be able to

- Know the classifications and applications of static relays.
- Understand the application of comparators.
- Understand the static version of different types of relays.
- Understand the numerical protection techniques.

Text Books:

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.

Reference Books:

1. Protective Relaying Vol-II Warrington, Springer.
2. Art & Science of Protective Relaying - C R Mason, Willey.
3. Power System Stability KimbarkVol-II, Willey.
4. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
5. Protection & Switchgear –BhaveshBhalaja, R.PMaheshwari, NileshG.Chothani-Oxford publisher

I Year - I Semester	22PPS08	L	T	P	C
		3	0	0	3

Power System Reliability
(Elective – II)

Pre-requisite: Probability theory, power systems.

Course Educational Objectives:

- To get the basic understanding of network modeling and reliability.
- To get the basic understanding of Markov chains.
- To get the basic understanding of Reliability analysis of generation systems.
- To get the basic understanding of Decomposition techniques

UNIT – 1

Basic probability theory – rules for combining probabilities of events – Bernoulli`s trials – probability density and distribution functions – binomial- distributions – expected value and standard deviation of binomial distribution.

UNIT – 2

Network Modelling and Reliability Analysis of Series, Parallel, Series-Parallel networks – complex networks – decomposition method

Reliability functions F(t), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponential distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF

UNIT – 3

Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabilities using STPM – two component repairable models – Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states

UNIT – 4

Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

UNIT – 5

Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

Course Outcomes: At the end of the course, student will be able to

- Understand reliability analysis applied to power systems.
- Understand Markov Chains and application to power systems.
- Perform stability analysis of generation systems.
- Understand decomposition techniques applied to power system.

Reference Books:

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Modeling in Electric Power Systems - J. Endrenyi, John Wiley, 1978, Neewyork.
3. An Introduction to Realiability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition.

I Year - I Semester	22PPS09	L	T	P	C
		0	0	0	0

Research Methodology and IPR

UNIT-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

I Year - I Semester	22PPS10	L	T	P	C
		0	0	4	0

Power System Simulation Lab-I

Pre-requisite: Electrical Power Systems

Course Educational Objectives:

- To understand the modelling of different transmission lines
- To understand the mathematical formulation of distribution system load flow
- To understand the configurations of transmission lines
- To understand the transients in transmission lines
- To understand the formation of Z- and Y-bus matrices

List of Experiments:

1. Performance analysis of short and medium transmission lines.
2. Performance analysis of long transmission lines.
3. Computation of sag of transmission lines for equal and unequal heights of towers.
4. Distribution load flow analysis.
5. Computation of B- co-efficient in economic load dispatch problem.
6. Computation of line parameters (R, L, C) for different configuration of 3-ϕ symmetrical transmission lines.
7. Computation of line parameters (R, L, C) for different configuration of 3-ϕ unsymmetrical transmission lines with and without transportation.
8. Computation reflection and refraction co-efficient of voltages and currents of transmission line form different conditions.
9. Formation of Y-bus by direct inspection method.
10. Formations of Z-bus by building algorithm.

Course Outcomes: The student shall be able to

1. Analyse the performance of thevarious transmission lines at different loading conditions
2. Perform the load flow study on distribution systems
3. Calculate the different line parameters of 3-phase symmetrical and unsymmetrical transmission lines
4. Compute the reflection and refraction coefficients of voltages and currents in the transmissions
5. Form the Z- and Y-bus matrices for the given power transmission system

I Year - I Semester	22PPS11	L	T	P	C
		0	0	4	0

Power System Laboratory

Course Educational Objectives:

To understand the experimental determination of various parameters used in power system area and to analyse the performance of transmission line with and without compensation.

List of Experiments:

1. Determination of Sequence Impendence of an Alternator by direct method.

2. Determination of Sequence impedance of an Alternator by fault Analysis.

3. Measurement of sequence impedance of a three phase transformer

(a). by application of sequence voltage. (b). using fault analysis.

4. Power angle characteristics of a salient pole Synchronous Machine.

5. Poly-phase connection on three single phase transformers and measurement of phase displacement.

6.Determination of equivalent circuit of 3-winding Transformer.

7. Measurement of ABCD parameters on transmission line model.

8. Performance of long transmission line without compensation.

9. Study of Ferranti effect in long transmission line.

10. Performance of long transmission line with shunt compensation.

Course Outcomes:

After the Completion of lab they will understand procedure for determination of various parameters used in power system as well as performance of transmission line.

I Year - II Semester	22PPS13	L	T	P	C
		3	0	0	3

Power System Dynamics and Stability

Pre-requisite: Knowledge of synchronous machine, Power System Analysis

Course Educational Objectives:

- To study the model of synchronous machines.
- To study the stability studies of synchronous machines.
- To study the solution method of transient stability.
- To study the effect of different excitation systems.

UNIT – 1

System Dynamics: Synchronous machine model in state space from computer representation for excitation and governor system –modelling of loads and induction machines.

UNIT – 2

Steady state stability – steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by eigen value approach.

UNIT – 3

Digital Simulation of Transient Stability: Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques: Modified Euler method – Runge Kutta method – Concept of multi machine stability.

UNIT – 4

Effect of governor action and excite on power system stability effect of saturation, saliency & automatic voltage regulators on stability.

UNIT – 5

Excitation Systems : Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system.

Course Outcomes: At the end of the course, student will be able to

- Determine the model of synchronous machines.
- Know the stability studies of synchronous machines.
- Get the knowledge of solution methods of transient stability.
- Know the effect of different excitation systems in power systems.

Text Books:

1. Power System Stability by Kimbark Vol. I&II, III, Willey.
2. Power System control and stability by Anderson and Fund, IEEE Press.

Reference Books:

1. Power systems stability and control by PRABHA KUNDUR, TMH.
2. Computer Applications to Power Systems–Glenn.W.Stagg& Ahmed. H.El.Abiad, TMH.
3. Computer Applications to Power Systems – M.A.Pai, TMH.
4. Power Systems Analysis & Stability – S.S.VadheraKhanna Publishers

I Year - II Semester	22PPS14	L	T	P	C
		3	0	0	3

Flexible AC Transmission Systems

Pre-requisite: Power system operation and control.

Course Educational Objectives:

- To understand the importance of state estimation in power systems.
- To know the importance of security and contingency analysis.
- To understand SCADA, its objectives and its importance in power systems.
- To know the significance of voltage stability analysis.
- To know the applications of AI to power systems problems.

UNIT – 1:
State Estimation: Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Bad data Observability, Bad data detection, identification and elimination.

UNIT – 2:
Security and Contingency Evaluation : Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.

UNIT – 3:
Computer Control of Power Systems: Need for real time and computer control of power systems, operating states of a power system, SCADA - Supervisory control and Data Acquisition systems implementation considerations, energy control centres, software requirements for implementing the above functions.

UNIT – 4:
Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis `P-V' curves and `Q-V' curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices.

UNIT – 5:
Synchrophasor Measurement units: Introduction, Phasor representation of sinusoids, a generic PMU, GPS, Phasor measurement systems, Communication options for PMUs, Functional requirements of PMUs and PDCs, Phasors for nominal frequency signals, types of frequency excursions in power systems, DFT estimation at off nominal frequency with a nominal frequency clock.

Course Outcomes: At the end of the course, student will be able to

- Understand state estimation, security and contingency evaluation.
- Understand about Supervisory control and data acquisition.
- Real time software application to state estimation.
- Understand application of AI in power system.

Text Books:

1. John J.Grainger and William D.Stevenson, Jr. : Power System Analysis, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg : Power Generation operation andcontrol, John Wiley & Sons, 1984.
3. A.G.Phadka and J.S. Thorp, "Synchronized Phasor Measurements and Their Applications", Springer, 2008

Reference Books:

1. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
2. L.P.Singh : Advanced Power System Analysis and Dynamics, WileyEastern Ltd. 1986
3. PrabhaKundur : Power System Stability and Control -, McGraw Hill, 1994
4. P.D.Wasserman : `Neural Computing : Theory and Practice' Van Nostrand -Feinhold, New York.

I Year - II Semester	22PPS15	L	T	P	C
		3	0	0	3

EHVAC Transmission

Pre-requisite: Transmission line parameters and properties, Corona etc.

Course Educational Objectives:

- To calculate the transmission line parameters.
- To calculate the field effects on EHV and UHV AC lines.
- To have knowledge of corona, RI and audible noise in EHV and UHV lines.
- To have knowledge of voltage control and compensation problems in EHV and UHV transmission systems.

UNIT – 1

A.C. Transmission, line trends and preliminary aspects, standard transmission voltages – power handling capacities and line losses – mechanical aspects. Calculation of line resistance and inductance: resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix. Line capacitance calculation. Capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.

UNIT – 2

Calculation of electro static field of AC lines - Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.

UNIT – 3

Corona : Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.

UNIT – 4

Power Frequency voltage control : Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series – capacitor compensated lines

UNIT – 5

Reactive power compensating systems: Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system.

Course Outcomes: At the end of the course, student will be able to

- Calculate the transmission line parameters.
- Calculate the field effects on EHV and UHV AC lines.
- Determine the corona, RI and audible noise in EHV and UHV lines.
- Analyse voltage control and compensation problems in EHV and UHV transmission systems.
- Understand reactive power compensation using SVC and TCR

Text Books :

1. Extra High Voltage AC Transmission Engineering – Rakesh Das Begamudre, Wiley Eastern ltd., New Delhi – 1987.
2. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.

I Year - II Semester	22PPS16	L	T	P	C
		3	0	0	3

REAL TIME CONTROL OF POWER SYSTEMS

(ELECTIVE–III)

Pre-requisite: Power system operation and control.

Course Educational Objectives:

- To understand the importance of state estimation in power systems.
- To know the importance of security and contingency analysis.
- To understand SCADA, its objectives and its importance in power systems.
- To know the significance of voltage stability analysis.
- To know the applications of AI to power systems problems.

UNIT – 1:

State Estimation: Different types of State Estimations, Theory of WLS state estimation, sequentialand non-sequential methods to process measurements. Bad data Observability, Bad data detection,identification and elimination.

UNIT – 2:

Security and Contingency Evaluation : Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, FastDecoupled model, and network sensitivity methods.

UNIT – 3:

Computer Control of Power Systems: Need for real time and computer control of power systems,operating states of a power system, SCADA - Supervisory control and Data Acquisition systemsimplementation considerations, energy control centres, software requirements for implementing the above functions.

UNIT – 4:

Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor anglestability. Voltage stability analysis Introduction to voltage stability analysis `P-V′ curves and `Q-V′ curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices.

UNIT – 5:

Synchrophasor Measurement units: Introduction, Phasor representation of sinusoids, a generic PMU,GPS, Phasor measurement systems, Communication options for PMUs, Functional requirements of PMUs and PDCs, Phasors for nominal frequency signals, types of frequency excursions in power systems, DFT estimation at off nominal frequency with a nominal frequency clock.

Course Outcomes: At the end of the course, student will be able to

- Understand state estimation, security and contingency evaluation.
- Understand about Supervisory control and data acquisition.
- Real time software application to state estimation.
- Understand application of AI in power system.

Text Books:

1. John J.Grainger and William D.Stevenson, Jr. : Power System Analysis, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg : Power Generation operation andcontrol, John Wiley & Sons, 1984.
3. A.G.Phadka and J.S. Thorp, "Synchronized Phasor Measurements and Their Applications", Springer, 2008

Reference Books:

1. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
2. L.P.Singh : Advanced Power System Analysis and Dynamics, WileyEastern Ltd. 1986
3. PrabhaKundur : Power System Stability and Control -, McGraw Hill, 1994
4. P.D.Wasserman : `Neural Computing : Theory and Practice' Van Nostrand -Feinhold, New York.

I Year - II Semester	22PPS17	L	T	P	C
		3	0	0	3

ANALYSIS OF POWER ELECTRONIC CONVERTERS

(ELECTIVE–III)

Course Educational Objectives:

- To understand the control principle of ac-to-ac conversion with suitable power semi - conductor devices.
- To have the knowledge of ac to dc conversion and different ac to dc converter topologies.
- To understand the effect of operation of controlled rectifiers on p.f. and improvement of p.f. with PFC converters
- To acquire the knowledge on dc-ac converters and to know the different control techniques of dc-ac converters.
- To know multilevel inverter configuration to improve the quality of the inverter output voltage.

UNIT– 1

Overview of Switching Devices:

Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices.

UNIT– 2

AC-DC converters: Single phase fully controlled converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters.

UNIT– 3

Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

UNIT– 4

PWM Inverters: Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques- Three phase current source inverters-Variable dc link inverter.

UNIT– 5

Multi level inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying- Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters.

Course Outcomes: At the end of the course, student will be able to

- Describe and analyze the operation of AC-DC converters.
- Analyze the operation of power factor correction converters.
- Analyze the operation of three phase inverters with PWM control.
- Study the principles of operation of multi- level inverters and their applications.

Text Books

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
2. Daniel W. Hart - McGraw-Hill,2011.

Reference Books:

1. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
2. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.

I Year - II Semester	22PPS18	L	T	P	C
		3	0	0	3

Generation & Measurement of High Voltages

(ELECTIVE–II)

Pre-requisite: Basics of Electrical circuits, Electronics and measurements for testing purpose.

Course Educational Objectives:

- To study the numerical methods for analysing electrostatic field problems.
- To study the fundamental principles of generation of high voltage for testing.
- To study the methods for measurement of high AC ,DC and transient voltages.
- To Study the measurement techniques for high AC ,DC and impulse currents.

UNIT – 1

Electrostatic fields and field stress control : Electric fields in homogeneous Isotropic materials and in multi dielectric media-Simple configurations-field stress control. Methods of computing electrostatic fields-conductive analogues-Impedance networks Numerical techniques-finite difference method-finite element method and charge simulation method.

UNIT – 2

Generation of High AC & DC Voltages:

Direct Voltages : AC to DC conversion methods, electrostatic generators, Cascaded Voltage Multipliers.

Alternating Voltages : Cascading transformers-Resonant circuits and their applications, Tesla coil.

UNIT – 3

Generation of Impulse Voltages :

Impulse voltage specifications-Impulse generation circuits-Operation, construction and design of Impulse generators-Generation of switching and long duration impulses.

Impulse Currents: Generation of high impulse currents and high current pulses.

UNIT – 4

Measurement of High AC & DC Voltages :

Measurement of High D.C. Voltages : Series resistance meters, voltage dividers and generating voltmeters.

Measurement of High A.C. Voltages : Series impedance meters electrostatic voltmeters potential transformers and CVTS-voltage dividers and their applications.

UNIT – 5

Measurement of Peak Voltages :

Sphere gaps, uniform field gaps, rod gaps. Chubb-Fortesque method, passive and active rectifier circuits for voltage dividers.

Measurement of Impulse Voltages: Voltage dividers and impulse measuring systems-generalized voltage measuring circuits-transfer characteristics of measuring circuits-L.V. Arms for voltage dividers-compensated dividers.

Measurement of Impulse Currents: Resistive shunts-current transformers-Hall Generators and Faraday generators and their applications-Impulse Oscilloscopes.

Course Outcomes: At the end of the course, student will be able to

- Understand numerical computation of electrostatic problems.
- Understand the techniques of generation of high AC, DC and transient voltages.
- Measure high AC, DC and transient voltages.
- Measure high AC, DC and transient currents.

Text Books:

1. High Voltage Engineering – by E.Kuffel and W.S.Zaengl. Pergaman press Oxford, 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Mc.Graw-Hill Books Co., New Delhi, 2nd edition, 1995.

Reference Books:

1. High Voltage Technology – LL Alston, Oxford University Press 1968.
2. High Voltage Measuring Techniques – A. Schwab MIT Press, Cambridge,USA, 1972.
3. Relevant I.S. and IEC Specifications.

I Year - II Semester	22PPS19	L	T	P	C
		3	0	0	3

Evolutionary Algorithms and Applications

(ELECTIVE–II)

Pre-Requisite: i) Optimization Techniques ii) Power System Operation

Course Educational Objectives:

- To distinguish between conventional optimization algorithms and evolutionary optimization algorithms.
- To apply genetic algorithm and particle swarm optimization algorithm to power system optimization problems.
- To analyse and apply Ant colony optimization algorithm and artificial Bee colony algorithm to optimize the control parameters./power system optimization problems.
- To apply shuffled frog leaping algorithm and bat optimization algorithm to power system optimization problem.
- To apply multi-objective optimization algorithm to power system multi-objective problems.

UNIT– 1

Fundamentals of Soft Computing Techniques

Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

UNIT– 2

Genetic Algorithm and Particle Swarm Optimization

Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters – GA and PSO algorithms for solving ELD problem without loss, Selective Harmonic Elimination in inverters and PI controller tuning.

UNIT– 3

Ant Colony Optimization and Artificial Bee Colony Algorithms

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max min ant system - Concept of Elitist Ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms – ACO and ABC algorithms for solving Economic Dispatch without loss and PI controller tuning.

UNIT– 4

Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm

Bat Algorithm- Echolocation of bats- Behaviour of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogscomparison of memes and genes -memeplex formation- memeplexupdation- BA and SFLA algorithms for solving ELD without loss and PI controller tuning.

UNIT– 5

Multi Objective Optimization

Multi-Objective optimization Introduction- Concept of Pareto optimality - Non-dominant sorting technique-Pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and application to general two objective optimization problem.

Course Outcomes: At the end of the course, student will be able to

- State and formulate the optimization problem, without and with constraints, by using design variables from an engineering design problem.
- Apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints, and arrive at an optimal solution.
- Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.
- Apply gradient and non-gradient methods to nonlinear optimization problems and use interior or exterior penalty functions for the constraints to derive the optimal solutions.
- Apply Genetic algorithms for simple electrical problems and able to solve practical problems using PSO.

Text Books

1. Xin-She Yang, „Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb „Multi-Objective Optimization using Evolutionary Algorithms", John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, „Swarm Intelligence", The Morgan Kaufmann Series in Evolutionary Computation, 2001.

Reference Books:

1. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, „Swarm Intelligence-From natural to Artificial Systems", Oxford university Press, 1999.
2. David Goldberg, „Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2007.
3. Konstantinos E. Parsopoulos and Michael N. Vrahatis, „Particle Swarm Optimization and Intelligence: Advances and Applications", InformatIonscIence reference, IGI Global, , 2010.
4. N P Padhy, „Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

Reference Papers:

1. "Shuffled frog-leaping algorithm: a memetic meta-heuristic for discrete optimization" by Muzaffareusuff, Kevin lansey and Fayzul pasha, Engineering Optimization, Taylor & Francis, Vol. 38, No. pp.129–154, March 2006.
2. "A New Metaheuristic Bat-Inspired Algorithm" by Xin-She Yang, Nature Inspired Cooperative Strategies for Optimization (NISCO 2010) (Eds. J. R. Gonzalez et al.), Studies in Computational Intelligence, Springer Berlin, 284, Springer, 65-74 (2010).
3. "Firefly Algorithms for Multimodal Optimization" Xin-She Yang, O. Watanabe and T. Zeugmann (Eds.), Springer-Verlag Berlin Heidelberg, pp. 169–178, 2009.

I Year - II Semester	22PPS20	L	T	P	C
		3	0	0	3

Programmable Logic Controllers & Applications

(ELECTIVE–IV)

Pre-requisite: Knowledge on relay logic and digital electronics

Course Educational Objectives:

- To have knowledge on PLC.
- To acquire the knowledge on programming of PLC.
- To understand different PLC registers and their description.
- To have knowledge on data handling functions of PLC.
- To know how to handle analog signal and converting of A/D in PLC.

UNIT– 1

PLC Basics:

PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT– 2

PLC Programming:

Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT– 3

PLC Registers:

Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

UNIT– 4

Data Handling functions:

SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.

UNIT– 5

Analog PLC operation:

Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Course Outcomes: At the end of the course, student will be able to

- Understand the PLCs and their I/O modules.
- Develop control algorithms to PLC using ladder logic etc.
- Manage PLC registers for effective utilization in different applications.
- Handle data functions and control of two axis and their axis robots with PLC.
- Design PID controller with PLC.

Text Books:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.

Reference Books:

1. Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.
2. Programmable Logic Controllers –W.Bolton-Elsevier publisher.

I Year - II Semester	22PPS21	L	T	P	C
		0	0	4	0

Power System Simulation Lab - II

Pre-requisite: Power systems

Course Educational Objectives:

The student should understand the modelling of various aspects of Power System analysis and develop the MATLAB programming.

List of Experiments

1 Load Flow Solution Using Gauss Siedel Method

2 Load Flow Solution Using Newton Raphson Method

3 Load Flow Solution Using Decoupled Method

4 Symmetrical Fault analysis using Z-bus

5 Unsymmetrical Fault analysis using Z-bus

6 Economic Load Dispatch with & without transmission losses

7 Transient Stability Analysis using modified Euler's method.

8 Transient Stability Analysis using modified R-K method.

9 Transient Stability Analysis Using Point By Point Method

10 Load Frequency Control of Single Area Control & Two Area Control system with and without controllers.

Course Outcomes:

The student should analyze load flow solution obtained using GS and NR methods, symmetrical and unsymmetrical faults, Transient stability and load frequency deviation in single and two area systems

I Year - II Semester	22PPS22	L	T	P	C
		0	0	4	0

Power Converters Lab

Pre-requisite: Fundamentals of Power Electronics

Course Educational Objectives: To study and understand the different converters and inverters for single and three phase loads.

Any 10 of the following experiments are to be conducted.

List of experiments

1. Study of DC-DC non-isolated converters such as Buck & Boost converter.
2. Study of DC-DC Buck-Boost and Cuk converters.
3. Study of 1-ϕ dual converter.
4. Determination of input p.f. and harmonic factor for 1-ϕ semi- converter and 1-ϕ full-converter (Inductive load)
5. Study of p.f. improvement in 1-ϕ full-converter with symmetric and extinction angle control.
6. Study of 1-ϕ square wave and sinusoidal PWM inverter.
7. Study of 3-ϕ inverter with 120^o and 180^o mode of operation.
8. Study of 3-ϕ sinusoidal PWM inverter.
9. Study of 3-level NPC inverter.
10. Study of 5-level cascaded H-bridge inverter.
11. Determination of input p.f. and harmonic factor for 3-ϕ full converter (Inductive load).
12. Determination of input p.f. and harmonic factor for 3-ϕ semi converter (Inductive load).
13. Study the characteristics of IGBT, MOSFET & GTO's.
14. Design of gate drive circuits for IGBT & MOSFET's.

Course Outcomes: Students are able to implement the converter and inverters in real time applications.

I Year - II Semester	22PPS23	L	T	P	C
		0	0	4	0
Mini Project with Seminar					

Note:
It is recommended that a Supervisor/advisor should be allotted to each student at the end of the semester-I or allot at the start of the semester-II

Syllabus content:

A Student has to select one paper published in any of the IEEE Transactions and simulate the same. The student has to present the progress of the work at the middle of the semester. At the end of the semester, the student has to present the results by explaining the idea of the topic, methodology, finding of the simulations. A Student should also submit a report of the entire work carried out under this course. The end semester presentation must be video recorded and preserved.

II Year - I Semester	22PPS25	L	T	P	C
		3	0	0	3

Energy Audit Conservation & Management

Pre-requisite: Electrical power systems and measurements.

Course Educational Objectives:

- To learn the basics of energy audit and energy conservation schemes.
- To comprehend the principles of energy management and understand the need of energy efficient motors and lighting design practices.
- To learn about power factor improvement techniques and energy instruments.
- To learn about the economic aspects o\f energy equipment.

UNIT– 1

Basic Principles of Energy Audit

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams and load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

UNIT– 2

Energy Management

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manager, qualities and functions, language, Questionnaire – check list for top management

UNIT– 3

Energy Efficient Motors and Lighting

Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics – variable speed , variable duty cycle systems, RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice, lighting control, lighting energy audit

UNIT– 4

Power Factor Improvement and energy instruments

Power factor – methods of improvement, location of capacitors, Power factor with non-linear loads, effect of harmonics on p.f, p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's

UNIT– 5

Economic Aspects and their computation

Economics Analysis depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present value method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment.

Course Outcomes: At the end of the course, student will be able to

- Understand the principle of energy audit and their economic aspects.
- Recommend energy efficient motors and design good lighting system.
- Understand advantages to improve the power factor.
- Evaluate the depreciation of equipment.

Text Books:

1. Energy management by W.R.Murphy&G.Mckay Butter worth, Heinemann publications, 1982.
2. Energy management hand book by W.CTurner, John Wiley and sons, 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas, Marcel Dekker Inc Ltd-2nd edition,1995
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

II Year - I Semester	22PPS26	L	T	P	C
		3	0	0	3

Smart Grid Technologies

Pre-requisite: Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

Course Educational Objectives:

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.

UNIT – 1

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

UNIT – 2

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

UNIT – 3

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

UNIT – 4

Micro grids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT – 5

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

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN).

Course Outcomes:

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

- Understand smart grids and analyze the smart grid policies and developments in smart grids.
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- Understand smart substations, feeder automation, GIS etc.
- Analyze micro grids and distributed generation systems.
- Analyze the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, "Smart Grid: Technology and Applications", Wiley
2. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
3. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
5. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
6. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011

II Year - I Semester	22PPS27	L	T	P	C
		3	0	0	3

Power Quality And Custom Power devices

Pre requisite: Knowledge on electric circuit analysis, power systems and power electronics and concept of reactive power compensation techniques.

Course Educational Objectives:

- To understand significance of power quality and power quality parameters.
- To know types of transient over voltages and protection of transient voltages.
- To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
- To understand the importance of power devices and their applications.
- To understand different compensation techniques to minimize power quality disturbances.

UNIT– 1

Introduction to power quality: Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags, swells, flicker and Interruptions - Sources of voltage and current interruptions, Nonlinear loads.

UNIT– 2

Transient and Long Duration Voltage Variations: Source of Transient Over Voltages - Principles of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor Switching Transients, Utility Lightning Protection, Load Switching Transient Problems.

Principles of Regulating the Voltage, Device for Voltage Regulation, Utility Voltage Regulator Application, Capacitor for Voltage Regulation, End-user Capacitor Application, Regulating Utility Voltage with Distributed generation

UNIT– 3

Harmonic Distortion and solutions: Voltage vs. Current Distortion, Harmonics vs. Transients - Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion, Inter harmonics, Harmonic Solutions Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics

UNIT– 4

Custom Power Devices: Custom power and custom power devices, voltage source inverters, reactive power and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distribution systems, interaction with distribution equipment, installation considerations.

UNIT– 5

Application of custom power devices in power systems: Static and hybrid Source Transfer Switches, Solid state current limiter - Solid state breaker. P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR): Operation and control – Interline Power Flow Controller (IPFC): Operation and control of Unified Power Quality Conditioner (UPQC); Generalized power quality conditioner

Course Outcomes: At the end of the course, student will be able to

- Identify the issues related to power quality in power systems.
- Address the problems of transient and long duration voltage variations in power systems.
- Analyze the effects of harmonics and study of different mitigation techniques.
- Identify the importance of custom power devices and their applications.
- Acquire knowledge on different compensation techniques to minimize power quality disturbances.

Text Books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
3. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
4. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, ArindamGhosh, Kluwer Academic Publishers, 2002.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
2. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
3. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
4. Power Quality c.shankaran, CRC Press, 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis).
6. Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, Mohammad A.S. Masoum-Elsevier
7. Power Quality, C. Shankaran, CRC Press, 2001
8. Instantaneous Power Theory and Application to Power Conditioning, H. Akagiet.al., IEEE Press, 2007.
9. Custom Power Devices - An Introduction, ArindamGhosh and Gerard Ledwich, Springer, 2002
10. A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.

II Year - I Semester	22PPS28	L	T	P	C
		3	0	0	3

Industrial Safety
(Open Elective)

Pre-requisite: Engineering Fundamentals

Course Educational Objectives:

- To learn safety aspects of any industrial area
- To learn fundamentals and types of maintenance engineering
- To learn causes and effects of wear and Corrosion and their prevention
- To learn identification of faults and their repair
- To learn preventive maintenance- periodic an preventive-maintenance of industrial systems

Unit-I: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and fire fighting, equipment and methods.

Unit-II: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV: Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Course Outcomes: At the end of the course, the student should be able to

- Understand the general industrial requirements like lighting, cleanliness prevention from hazards and accidents.
- Analyze maintenance requirements of the industry and cost associated.
- Analyze wear and corrosion aspects of the industry and their prevention.
- Identify the faults prone areas and their repair and periodic maintenance.

Reference Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

II Year - I Semester	22PPS29	L	T	P	C
		3	0	0	3

Artificial Intelligent Techniques (Open Elective)

Pre–requisite: Fundamentals of Neural networks and Fuzzy Logic.

Course Educational Objectives:

- To have knowledge on concept of neural network.
- To know different types of neural networks and training algorithms.
- To understand the concept of genetic algorithm and its application in optimization.
- To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
- To know the applications of AI Techniques in electrical engineering.

UNIT– 1

Introduction

Artificial Neural Networks (ANN) – definition and fundamental concepts – Biological neural networks – Artificial neuron – activation functions – setting of weights – typical architectures – biases and thresholds – learning/training laws and algorithms. Perceptron – architectures, ADALINE and MADLINE – linear separability- XOR function.

UNIT– 2

ANN Paradigms

ADALINE – feed forward networks – Back Propagation algorithm- number of hidden layers – gradient decent algorithm – Radial Basis Function (RBF) network. Kohonen's self organizing map (SOM), Learning Vector Quantization (LVQ) and its types – Functional Link Networks (FLN) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.

UNIT– 3

Classical and Fuzzy Sets

Introduction to classical sets- properties, Operations and relations; Fuzzy sets, Membership, Operations, Properties, Fuzzy relations, Cardinalities, Membership functions.

UNIT– 4

FUZZY LOGIC CONTROLLER (FLC)

Fuzzy logic system components: Fuzzification, Inference engine (development of rule base and decision making system), Defuzzification to crisp sets- Defuzzification methods.

UNIT– 5

Application of AI Techniques

Speed control of DC motors using fuzzy logic –load flow studies using back propagation algorithm, single area and two area load frequency control using fuzzy logic.

Course Outcomes: At the end of the course, student will be able to

- Differentiate between Algorithmic based methods and knowledge based methods.
- Use appropriate AI framework for solving power system problems.
- To design fuzzy logic controllers for power engineering applications.

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zurada, Jaico Publishing House, 1997.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – McGraw Hill Inc, 1997.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.
2. Modern power Electronics and AC Drives – B.K.Bose -Prentice Hall, 2002
3. Genetic Algorithms- David E Goldberg. Pearson publications.
5. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam,SSumathi,S N Deepa TMGH
6. Introduction to Fuzzy Logic using MATLAB by S N Sivanandam,SSumathi,S N Deepa Springer, 2007.

II Year - I Semester	22PPS30	L	T	P	C
		3	0	0	3

Operations Research
(Open Elective)

Pre –requisite: Engineering Mathematics

Course Educational Objectives:

- To understand the mathematical modelling of physical systems and its solving techniques with and without constraints.
- To understand the solving of LPP problem using graphical and simplex method.
- To understand the Solving of non-linear programming problem.
- To understand the scheduling and sequencing problem of different models with geometric programming.
- To understand the Solving of LPP using dynamic programming and graph theory.

Unit 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques,Sensitivity Analysis, Inventory Control Models

Unit 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplexmethod - sensitivity analysis - parametric programming

Unit 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flowproblem - CPM/PERT

Unit 4

Scheduling and sequencing - single server and multiple server models - deterministic inventorymodels - Probabilistic inventory control models - Geometric Programming.

Unit 5

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Course Outcomes: At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

II Year - I Semester	22PPS31	L	T	P	C
		0	0	20	10
Dissertation Phase - I					

II Year - II Semester	22PPS32	L	T	P	C
		0	0	32	16
Dissertation Phase - II					