CHRIST (Deemed to be University)

School of Engineering and Technology

Department of Electrical & Electronics Engineering

M. Tech (Power Systems)

Syllabus 2020-22

I Semester							
Sl.No	**Type**	**Course Name**	**Theory Hrs**	**Tutorial Hrs**	**Practical Hrs**	**Hrs/ Week**	**Total Credits**
1	Core 1 MTEE131	Modern Power System Analysis	3	0	0	3	3
2	Core 2 MTEE132	Power System Dynamics I	3	0	0	3	3
3	Program Elective I MTEE133X	Program Elective I	3	0	0	3	3
4	Program Elective II MTEE134X	Program Elective II	3	0	0	3	3
5	Core lab I MTEE151	Modern Power System Analysis Laboratory	0	0	2	2	2
6	Core lab II MTEE152	Smart Grid Laboratory	0	0	2	2	2
7	MLC MTEEMC1	Research Methodology and IPR	2	0	0	2	2
8	Audit MTEEAC1	Audit Course I	2	0	0	2	0
9	HE171	Holistic Education	1	0	0	1	1
		Total	**17**	**0**	**4**	**21**	**19**

II Semester							
Sl.No	**Type**	**Course Name**	**Theory Hrs**	**Tutorial Hrs**	**Practical Hrs**	**Hrs/ Week**	**Total Credits**
1	Core 3 MTEE231	Digital Protection of Power System	3	0	0	3	3
2	Core 4 MTEE232	Power System Dynamics-II	3	0	0	3	3
3	Program Elective III MTEE233X	Program Elective III	3	0	0	3	3
4	Program Elective IV MTEE234X	Program Elective IV	3	0	0	3	3
5	Core lab III MTEE251	HV & Power System Protection Laboratory	0	0	2	2	2
6	Core lab IV MTEE252	Renewable Energy System Laboratory	0	0	2	2	2
7	Core 5 MTEE271	Mini Project	0	0	4	4	2
8	Audit MTEEAC2	Audit Course-2	2	0	0	2	0
9	HE271	Holistic Education	1	0	0	1	1
		Total	**15**	**0**	**8**	**23**	**19**

III Semester							
Sl.No	**Type**	**Course Name**	**Theory Hrs**	**Tutorial Hrs**	**Practical Hrs**	**Hrs/ Week**	**Total Credits**
1	Program Elective V MTEE331X	Program Elective V	3	0	0	3	3
2	Open Elective MTEEOE1	1. Business Analytics	3	0	0	3	3
3	Major Project MTEE371	Phase – I Dissertation	0	0	20	20	10
4	MTEE372	Internship	0	0	4	4	2
		Total	**6**	**0**	**24**	**30**	**18**

IV Semester							
Sl.No	**Type**	**Course Name**	**Theory Hrs**	**Tutorial Hrs**	**Practical Hrs**	**Hrs/ Week**	**Total Credits**
1	Major Project MTEE471	Phase-II Dissertation	0	0	32	32	16
		Total	**0**	**0**	32	32	**16**

Program Elective I
A.Smart grid
B. AI Techniques
C. Advanced Micro-Controller Based Systems
D. SCADA System and Applications

Program Elective II
A. High Power Converters
B. Power Apparatus Design
C. Power Quality
D. Dynamics of Electrical Machines

Program Elective III
A. Renewable Energy System
B. Wind and Solar Systems
C. Electrical Power Distribution System
D. Restructured Power Systems
Program Elective IV
A. Electric and Hybrid Vehicles
B. Pulse Width Modulation for PE Converters
C. Mathematical Methods for Power Engineering
D. Advanced Digital Signal Processing
Program Elective V
A. Power System Transients
B. FACTS and Custom Power Devices
C. Industrial Load Modeling and Control
D. Dynamics Of Linear Systems
Open Elective
1. Business Analytics
2. Industrial Safety
3. Operations Research
4. Cost Management of Engineering Projects
5. Composite Materials
6. Waste to Energy

Sem	Theory Hrs	Tutorial Hrs	Practical Hrs	Hrs/ Week	Total Credits
I	**17**	**0**	**4**	**21**	**19**
II	**15**	**0**	**8**	**23**	**19**
III	**6**	**0**	**24**	**30**	**18**
IV	**0**	**0**	**32**	**32**	**16**
Total	**38**	**0**	**68**	**106**	**72**

GRAND TOTAL CREDITS 72

Programme Outcomes of Power Systems Stream

PO1Ability to apply the enhanced knowledge in advanced technologies for modeling, analyzing and solving contemporary issues in power sector with a global perspective.

PO2Ability to critically analyze and carry out detailed investigation on multifaceted complex Problems in area of Power Systems and envisage advanced research in thrust areas.

PO3Ability to identify, analyze and solve real-life engineering problems in the area of Power Systems and provide strategic solutions satisfying the safety, cultural, societal and environmental aspects/ needs.

PO4Ability for continued pursuance of research and to design, develop and propose theoretical and practical methodologies towards research and development support for the Power System infrastructure.

PO5Ability to develop and utilize modern tools for modeling, analyzing and solving various Engineering problems related to Power Systems.

PO6 Willingness and ability to work in a team of engineers/ researchers with mutual understandings to take unsophisticated challenges, in the field of Power Systems, lead and motivate the group to inculcate multidisciplinary and collaborative approach.
PO7 Willingness and ability to take up administrative challenges including the management of various projects of interdisciplinary nature and carry out the same in an efficient
manner giving due consideration to societal, environmental, economical and financial factors.

PO8 Ability to express ideas clearly and communicate orally as well as in writing with others in an effective manner, adhering to various national and international standards and
practices for the documentation and presentation of the contents.

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.

CORE-1: POWER SYSTEM ANALYSIS

Course Objectives-

Students will be able to:

1. Study various methods of load flow and their advantages and disadvantages
2. Understand how to analyze various types of faults in power system
3. Understand power system security concepts and study the methods to rank the contingencies
4. Understand need of state estimation and study simple algorithms for state estimation
5. Study voltage instability phenomenon

Syllabus

Units	Content	Hours
1	• Load flow :Overview of Newton-Raphson ,Gauss-Siedel • fast decoupled methods, convergence properties, sparsity techniques, handling Q- max violations in constant matrix, inclusion in frequency effects • AVR in load flow, handling of discrete variable in load flow. • Fault Analysis**:** Simultaneous faults, • open conductors faults, • generalized method of fault analysis.	9
2	• Security Analysis: Security state diagram, contingency analysis, generator shift • distribution factors • line outage distribution factor, multiple line outages,overload index ranking	9
3	• Power System Equivalents **:** WARD • REI. equivalents	9
4	• State Estimation : Sources of errors in measurement • Virtual and Pseudo, • Measurement, Observability, • Tracking state estimation, • WSL method, bad data correction	9
5	• Voltage Stability : Voltage collapse, • P-V curve, mult iple power flow solut ion, • continuation power flow, optimal multiplies load flow, • voltage collapse proximity indices.	9

Suggested reading

1. J.J. Grainger &W.D.Stevenson, “Power system analysis ”, McGraw Hill ,2003

1. A. R. Bergen & Vijay Vittal , “Power System Analysis” ,Pearson , 2000
2. L.P. Singh , “Advanced Power System Analysis and Dynamics”, New Age International, 2006
3. G.L. Kusic, “Computer aided power system analysis” ,Prentice Hall India, 1986
4. A.J. Wood, “ Power generation, operation and control” , John Wiley, 1994
5. P.M. Anderson, “Faulted power system analysis” , IEEE Press , 1995

Course outcomes-

Students will be able to:

1. Able to calculate voltage phasors at all buses , given the data using various methods of load flow
2. Able to calculate fault currents in each phase
3. Rank various contingencies according to their severity
4. Estimate the bus voltage phasors given various quantities viz. power flow, voltages, taps , CB status etc
5. Estimate closeness to voltage collapse and calculate PV curves using continuation power flow

CORE-2: POWER SYSTEM DYNAMICS-I

Course Objectives:- Students will be able to:

1. Study of system dynamics and its physical interpretation
2. Development of mathematical models for synchronous machine
3. Modelling of induction motor

Syllabus

Units	Content	Hours
1	Synchronous Machines: Per unit systems Park’s Transformation (modified) Flux-linkage equations.	9
2	• Voltage and current equations • Formulation of State-space equations • Equivalent circuit.	9
3	• Sub-transient and transient inductance and Time constants, Simplified • models of synchronous machines • Small signal model: Introduction to frequency model.	9
4	• Excitation systems and Philips-Heffron model • PSS Load modelling.	9
5	• Modelling of Induction Motors • Prime mover controllers.	9

Suggested reading

1. P. M. Anderson & A. A. Fouad “Power System Control and Stability”, Galgotia , New Delhi, 1981
2. J Machowski, J Bialek& J. R W. Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997
3. P.Kundur, “Power System Stability and Control”, McGraw Hill Inc., 1994.
4. E.W. Kimbark, “Power system stability”, Vol. I & III, John Wiley & Sons, New York 2002

Course outcomes-

Students will be able to:
1. Understand the modeling of synchronous machine in details
2. Carry out simulation studies of power system dynamics using MATLAB-SIMULINK, MI POWER
3. Carry out stability analysis with and without power system stabilizer (PSS)
4. Understand the load modeling in power system 5. Estimate closeness to voltage collapse and calculate PV curves using continuation power flow

PE 1 : RENEWABLE ENERGY SYSTEM

Course Objectives:- Students will be able to:
1. To learn various renewable energy sources
2. To gain understanding of integrated operation of renewable energy sources
3. To understand Power Electronics Interface with the Grid

Syllabus

Units	Content	Hours
1	• Introduction, Distributed vs Central Station Generation • Sources of Energy such as Micro-turbines • Internal Combustion Engines.	8
2	• Introduction to Solar Energy, Wind Energy, Combined Heat and Power • Hydro Energy, Tidal Energy, Wave Energy • Geothermal Energy, Biomass and Fuel Cells.	8
3	• Power Electronic Interface with the Grid	6
4	• Impact of Distributed Generation on the Power System • Power Quality Disturbances	8
5	• Transmission System Operation • Protection of Distributed Generators	8
6	• Economics of Distributed Generation • Case Studies	6

Suggested reading

1. RanjanRakesh, Kothari D.P, Singal K.C, "Renewable Energy Sources and Emerging Technologies",
2nd Ed. Prentice Hall of India ,2011
2. Math H.Bollen, Fainan Hassan, "Integration of Distributed Generation in the Power System", July 2011,
Wiley –IEEE Press
3. Loi Lei Lai, Tze Fun Chan, "Distributed Generation: Induction and Permanent Magnet Generators",
October 2007, Wiley-IEEE Press.
4.Roger A.Messenger, Jerry Ventre, "Photovoltaic System Engineering", 3rd Ed,
2010 5.James F.Manwell, Jon G.McGowan, Anthony L Rogers, "Wind energy explained: Theory Design and Application", John Wiley and Sons 2nd Ed, 2010

Course Outcomes:- Students will be able to:

1. Knowledge about renewable energy
2. Understand the working of distributed generation system in autonomous/grid connected modes
3. Know the Impact of Distributed Generation on Power System

PE 1: SMART GRIDS

Course Objectives:- Students will be able to:

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

Syllabus

Units	Content	Hours
1	• Introduction to Smart Grid, Evolution of Electric Grid • Concept of Smart Grid, Definitions • Need of Smart Grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid	8
2	• 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 • Smart Substations, Substation Automation, Feeder Automation .	8
3	• 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)	8
4	• Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of micro-grid. • Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines • Captive power plants, Integration of renewable energy sources	8
5	• 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	6
6	• Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area • Network (NAN), Wide Area Network (WAN) • Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, • Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid • Broadband over Power line (BPL) • IP based protocols	6

Suggested reading

1. Ali Keyhani, “Design of smart power grid renewable energy systems”, Wiley IEEE, 2011
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press , 2009
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, “Smart Grid: Technology and Applications”, Wiley 2012
4. Stuart Borlase, “Smart Grid: Infrastructure, Technology and solutions “ CRC Press
5.A.G.Phadke, “Synchronized Phasor Measurement and their Applications”, Springer

Course Outcomes

Students will be able to:

1. Appreciate the difference between smart grid & conventional grid
2. Apply smart metering concepts to industrial and commercial installations
3. Formulate solutions in the areas of smart substations,distributed generation and wide area measurements
4. Come up with smart grid solutions using modern communication technologies

PE 1 : HIGH POWER CONVERTERS

Course Objectives:- Students will be able to:

1. Understand the requirements of high power rated converters
2. Understand the different topologies involved for these converters
3. Able to understand the design of protection circuits for these converters

Syllabus

Units	Content	Hours
1	• Power electronic systems • An overview of PSDs, multipulse diode rectifier, multipulse • SCR rectifier.	6
2	• Phase shifting transformers, multilevel voltage source inverters: two level voltage source inverter, • cascaded • H bridge multilevel inverter.	8
3	• Diode clamped multilevel inverters, flying capacitor multilevel inverter	6
4	• PWM current source inverters, • DC to DC switch mode converters	6
5	• AC voltage controllers : Cyclo-converters, matrix converter, • Power conditioners and UPS.	8
6	• Design aspects of converters, protection of devices and circuits	6

Suggested reading

1. N. Mohan, T. M. Undeland and W. P. Robbins, “Power Electronics: Converter, Applications and Design”,
John Wiley and Sons, 1989
2. M.H. Rashid, “Power Electronics”, Prentice Hall of India, 1994
3. B. K .Bose, “Power Electronics and A.C. Drives”, Prentice Hall, 1986
4. Bin Wu, “High power converters and drives”, IEEE press, Wiley Enter science

Course Outcomes:-

Students will be able to:

1. Learn the characteristics of PSDs such as SCRs, GTOs, IGBTs and use them in practical systems
2. Knowledge of working of multi-level VSIs, DC-DC switched mode converters, cyclo-converters

and PWM techniques and the ability to use them properly
3. Acquire knowledge of power conditioners and their applications
4. Ability to design power circuit and protection circuit of PSDs and converters

PE 1 : WIND AND SOLAR SYSTEMS

Course Objectives:-Students will be able to: 1. To get exposure to wind and solar systems 2. To understand the factors involved in installation and commissioning of a Solar or Wind plant. 3. Learning the dynamics involved when interconnected with power system grid		
Syllabus		
Units	**Content**	**Hours**
1	• Historical development and current status • characteristics of wind power generation • network integration issues	8
2	• Generators and power electronics for wind turbines, • power quality standards for wind turbines, • Technical regulations for interconnections of wind farm with power systems.	8
3	• Isolated wind systems, • reactive power and voltage control, • economic aspects.	8
4	• Impacts on power system dynamics, • power system interconnection	8
5	• Introduction of solar systems, • merits and demerits, concentrators, various applications.	6
6	• Solar thermal power generation, • PV power generation, • Energy Storage device. • Designing the solarsystem for small installations.	6

Suggested reading

1. Thomas Ackermann, Editor, "Wind power in Power Systems", John Willy and sons ltd.2005
2. Siegfried Heier, "Grid integration of wind energy conversion systems", John Willy and sons ltd., 2006
3. K. Sukhatme and S.P. Sukhatme, "Solar Energy". Tata MacGraw Hill, Second Edition, 1996

Course Outcomes:-

Students will be able to:
1. Appreciate the importance of energy growth of the power generation fromthe renewable energy sources and participate in solving these problems
2. Demonstrate the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems
3. Demonstrate the knowledge of physics of solar power generation and the associated issues
4. Identify, formulate and solve the problems of energy crises using wind and solar energy

PE 2: ELECTRIC POWER DISTRIBUTION SYSTEM

Course Objectives:-Students will be able to: 1. Learning about power distribution system 2. Learning of SCADA System 3. Understanding Distribution Automation

Syllabus		
Units	**Content**	**Hours**
1	• Distribution of Power, Management, Power Loads, • Load Forecasting Short-term & Long-term, • Power System Loading, Technological Forecasting.	8
2	• Advantages of Distribution Management System (D.M.S.) Distribution Automation: Definition, • Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints • Power Factor Correction	8
3	• Interconnection of Distribution, • Control & Communication Systems, • Remote Metering, • Automatic Meter Reading and its implementation	8
4	• SCADA: Introduction, Block Diagram, • SCADA Applied To Distribution Automation. • Common Functions of SCADA, • Advantages of Distribution Automation through SCADA	8
5	• Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, • Distribution Systems, Sectionalizing Switches – Types, Benefits, • Bellman's Optimality Principle, • Remote Terminal Units, • Energy efficiency in electrical distribution & Monitoring	6
6	• Maintenance of Automated Distribution Systems • Difficulties in Implementing Distribution. • Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation	6

Suggested reading

1. A.S. Pabla, " Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press, New Delhi
3. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press
4. James Momoh, "Electric Power Distribution, automation, protection & control", CRC Press

Course Outcomes :-Students will be able to:

1. Knowledge of power distribution system
2. Study of Distribution automation and its application in practice
3. To learn SCADA system

PE 2: MATHEMATICAL METHODS FOR POWER ENGINEERING

Course Objectives: -Students will be able to:
1. To understand the relevance of mathematical methods to solve engineering problems.
2. To understand how to apply these methods for a given engineering problem.

Syllabus		
Units	**Content**	**Hours**
1	• Vector spaces, • Linear transformations	6

	• Matrix representation of linear transformation	
2	• Eigen values and Eigen vectors of linear operator	6
3	• Linear Programming Problems • Simplex Method • Duality • Non Linear Programming problems	8
4	• Unconstrained Problems • Search methods • Constrained Problems	8
5	• Lagrange method • Kuhn-Tucker conditions • Random Variables • Distributions	8
6	• Independent Random Variables • Marginal and Conditional distributions • Elements of stochastic processes	8

Suggested reading

1. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1992
2. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, 2004
3. Irwin Miller and Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn, PHI, 2002
4. J. Medhi, "Stochastic Processes", New Age International, New Delhi., 1994
5. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002
6. John B Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley, 2000
7. Hillier F S and Liebermann G J, "Introduction to Operations Research", 7th Edition, McGraw Hill, 2001
8. Simmons D M, "Non Linear Programming for Operations Research", PHI, 1975

Course Outcomes: -

Students will be able to:
1. Knowledge about vector spaces, linear transformation, eigenvalues and eigenvectors of linear operators
2. To learn about linear programming problems and understanding the simplex method for solving linear programming problems in various fields of science and technology
3.Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems
4.Understanding the concept of random variables, functions of random variable and their probability distribution
5. Understand stochastic processes and their classification

PE 2 : PULSE WIDTH MODULATION FOR PE CONVERTERS

Course Objectives:-Students will be able to: 1. To understand Necessity and Importance of PWM techniques 2. Implementation of PWM controllers		
Syllabus		
Units	**Content**	**Hours**
1	• Introduction to PE converters	8

	• Modulation of one inverter phase leg • Modulation of single phase • VSI and 3 phase VSI	
2	• Zero space vector placement modulation strategies • Losses-Discontinuous modulation • Modulation of CSI	8
3	• Over modulation of converters • programme modulation strategies	8
4	• Pulse width modulation for multilevel inverters • Implementation of modulation controller	8
5	• Continuing developments in modulation as random PWM • PWM for voltage unbalance	6
6	• Effect of minimum pulse width and dead time	6

Suggested reading

1. D. Grahame Holmes, Thomas A. Lipo, "Pulse width modulation of Power Converter: Principles and Practice", John Wiley & Sons, 03-Oct-2003
2. Bin Vew, "High Power Converter", Wiley Publication
3. Marian K. Kazimicrczuk, "Pulse width modulated dc-dc power converter", Wiley Publication

Course Outcomes :-Students will be able to:

1.Appreciate importance of PWM techniques
2.Implement PWM using different strategies
3.Control CSI and VSI using PWM
4.Compare performance of converter for different PWM techniques

PE 2 : ELECTRIC AND HYBRID VECHILES

Course Objectives:-Students will be able to:
1. To understand upcoming technology of hybrid system
2. To understand different aspects of drives application
3. Learning the electric Traction

Syllabus

Units	Content	Hours
1	• History of hybrid and electric vehicles, • Social and environmental importance of hybrid and electric vehicles • Impact of modern drive-trains on energy supplies • Basics of vehicle performance, vehicle power source characterizationTransmission characteristics • Mathematical models to describe vehicle performance	8
2	• Basic concept of hybrid traction, • Introduction to various hybrid drive-train topologies • Power flow control in hybrid drive-train topologies • Fuel efficiency analysis.	8
3	• Basic concept of hybrid traction, • Introduction to various hybrid drive-train topologies • Power flow control in hybrid drive-train topologies • Fuel efficiency analysis.	8

4	• 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	8
5	• Matching the electric machine and the internal combustion engine (ICE) • Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology • Communications, supporting subsystems	8
6	• Introduction to energy management and their strategies used in hybrid and electric vehicle • Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies	6

Suggested reading

1. Sira -Ramirez, R. Silva Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, "Sliding mode control of switching Power Converters"

Course Outcomes :-

Students will be able to:
1. Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
2. To learn electric drive in vehicles / traction.

LAB 1- Modern Power System Analysis Laboratory

S.No	Experiments	Hours
1	Power Systems & Power Electronics Lab	
2	Computer Simulation Lab	
3	Simulation of IGBT Inverters.	
4	Simulation of Thyristor Converters.	
5	Transient Stability Studies.	
6	Short Circuit Studies.	
7	Load Flow Studies	
8	Load Forecasting and Unit Commitment	

LAB2- Smart Grid Laboratory

List of experiments:

S.No	Experiments
1	Power Curves
2	Build a Wind Farm
3	Test the Capabilities of the Hydrogen Fuel Cells and Capacitors
4	Effect of Temperature on Solar Panel Output
5	Variables Affecting Solar Panel Output
6	Effect of Load on Solar Panel Output
7	Wind Turbine Output: The Effect of Load
8	Test the Capabilities of Solar Panels and Wind Turbines

Research Methodology and IPR	
Teaching Scheme Lectures: 1hrs/week	

Course Outcomes:

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

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Contents:

Unit 1: 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 2: Effective literature studies approaches, analysis

Plagiarism, Research ethics,

Unit 3: 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 4: 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 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: 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:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
- Mayall , "Industrial Design", McGraw Hill, 1992.
- Niebel , "Product Design", McGraw Hill, 1974.
- Asimov , "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

SECOND SEMESTER

CORE - 3 : DIGITAL PROTECTION OF POWER SYSTEM

Course Objectives:-Students will be able to: 1. Study of numerical relays 2. Developing mathematical approach towards protection 3. Study of algorithms for numerical protection		
Syllabus		
Units	**Content**	**Hours**
1	• Evolution of digital relays from electromechanical relays • Performance and operational characteristics of digital protection	6
2	• Mathematical background to protection algorithms • Finite difference techniques	6
3	• Interpolation formulae • Forward, backward and central difference interpolation • Numerical differentiation • Curve fitting and smoothing • Least squares method • Fourier analysis • Fourier series and Fourier transform • Walsh function analysis	8
4	• Basic elements of digital protection • Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers • Conversion subsystem: the sampling theorem, signal aliasing	8
	• Error, sample and hold circuits, multiplexers, analog to digital conversion • Digital filtering concepts, • The digital relay as a unit consisting of hardware and software	
5	• Sinusoidal wave based algorithms • Sample and first derivative (Mann and Morrison) algorithm. • Fourier and Walsh based algorithms	8
6	• Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm. • Walsh function based algorithm. • Least Squares based algorithms. Differential equation based algorithms. • Traveling Wave based Techniques. • Digital Differential Protection of Transformers. • Digital Line Differential Protection. • Recent Advances in Digital Protection of Power Systems.	8

Suggested reading

1. A.G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009

2. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press,1999

3. Gerhard Zeigler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006
4.S.R.Bhide “Digital Power System Protection” PHI Learning Pvt.Ltd.2014

Course Outcomes:-

Students will be able to:
1. Learn the importance of Digital Relays
2. Apply Mathematical approach towards protection
3. Learn to develop various Protection algorithms

CORE - 4:POWER SYSTEM DYNAMICS-II

Course Objectives:-Students will be able to:
1. Study of power system dynamics
2. Interpretation of power system dynamic phenomena
3. Study of various forms of stability

Syllabus

Units	Content	Hours
1	• Basic Concepts of Dynamic Systems and Stability Definition • Small Signal Stability (Low Frequency Oscillations) of Unregulated and Regulated System	8
2	• Effect of Damper, Flux Linkage Variation and AVR	8
3	• Large Signal Rotor Angle Stability • Dynamic Equivalents And Coherency • Direct Method of Stability Assessment • Stability Enhancing Techniques • Mitigation Using Power System Stabilizer	8
4	• Asynchronous Operation and Resynchronization • Multi-Machine Stability	6
5	• Dynamic Analysis of Voltage Stability	6
	• Voltage Collapse	
6	• Frequency Stability • Automatic Generation Control • Primary and Secondary Control • Sub-Synchronous Resonance and Counter Measures	8

Suggested reading

1. P. Kundur, “Power System Stability and Control”, McGraw Hill Inc, 1994
2. J. Machowski, Bialek, Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997

3. L. Leonard Grigsby (Ed.); “Power System Stability and Control”, Second edition, CRC Press, 2007
4. V. Ajjarapu, “Computational Techniques for voltage stability assessment & control”; Springer, 2006

Course Outcomes:-

Students will be able to:
1. Gain valuable insights into the phenomena of power system including obscure ones.
2. Understand the power system stability problem.
3. Analyze the stability problems and implement modern control strategies.

4. Simulate small signal and large signal stability problems.

PE 3: RESTRUCTURED POWER SYSTEMS

Course Objectives: -Students will be able to:
1. Understand what is meant by restructuring of the electricity market
2. Understand the need behind requirement for deregulation of the electricity market
3. Understand the money, power & information flow in a deregulated power system

Syllabus

Units	Content	Hours
1	• Fundamentals of restructured system • Market architecture • Load elasticity • Social welfare maximization	8
2	• OPF: Role in vertically integrated systems and in restructured markets • congestion management	8
3	• Optimal bidding • Risk assessment • Hedging • Transmission pricing • Tracing of power	8
4	• Ancillary services • Standard market design • Distributed generation in restructured markets	8
5	• Developments in India • IT applications in restructured markets	6
6	• Working of restructured power systems • PJM, Recent trends in Restructuring	6

Suggested reading

1. LorrinPhilipson, H. Lee Willis, "Understanding electric utilities and de-regulation", Marcel Dekker Pub.,1998.
2. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 2002.
3. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
4. Mohammad Shahidehpour, MuwaffaqAlomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker.

Course Outcomes: -Students will be able to:

1. Describe various types of regulations in power systems.
2. Identify the need of regulation and deregulation.
3. Define and describe the Technical and Non-technical issues in Deregulated Power Industry.
4. Identify and give examples of existing electricity markets.
5.Classify different market mechanisms and summarize the role of various entities in the market.

PE 3:ADVANCED DIGITAL SIGNAL PROCESSING

Course Objectives: -Students will be able to:
1. To understand the difference between discrete-time and continuous-time signals
2. To understand and apply Discrete Fourier Transforms (DFT)

Syllabus		
Units	**Content**	**Hours**
1	• Discrete time signals • Linear shift invariant systems- • Stability and causality • Sampling of continuous time signals- • Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform • Z transform-Properties of different transforms	8
2	• Linear convolution using DFT • Computation of DFT Design of IIR digital filters from analog filters • Impulse invariance method • Bilinear transformation method	8
3	• FIR filter design using window functions • Comparison of IIR and FIR digital filters • Basic IIR and FIR filter realization structures • Signal flow graph representations Quantization process and errors • Coefficient quantisation effects in IIR and FIR filters	8
4	• A/D conversion noise- Arithmetic round-off errors • Dynamic range scaling • Overflow oscillations and zeroInput limit cycles in IIR filters • Linear Signal Models	8
5	• All pole, All zero and Pole-zero models • Power spectrum estimation- Spectral analysis of deterministic signals. • Estimation of power spectrum of stationary random signals	6
6	• Optimum linear filters • Optimum signal estimation • Mean square error estimation	6
	• Optimum FIR and IIR Filters	

Suggested reading

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",TataMc Grow-Hill Edition1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions. -2000

Course Outcomes:-

Students will be able to:

1. Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems
2. Study the design techniques for IIR and FIR filters and their realization structures.
3. Acquire knowledge about the finite word length effects in implementation of digital filters.
4. Knowledge about the various linear signal models and estimation of power spectrum of stationary random signals
5. Design of optimum FIR and IIR filters

PE 3: DYNAMICS OF ELECTRICAL MACHINES

Course objective: -Students will be able to-

1. Learn Performance characteristics of machine
2. To understand the dynamics of the machine
3. To understand how to determine stability of machine
4. Learn the synchronous machine

Syllabus

Units	Content	Hours
1	• Stability,Primitive 4 Winding Commutator Machine • Commutator Primitive Machine • Complete Voltage Equation of Primitive 4 Winding Commutator Machine	8
2	• Torque EquationAnalysis of Simple DC Machines using the Primitive Machine Equations • The Three Phase Induction Motor. • Transformed Equations • Different Reference Frames for Induction Motor Analysis Transfer Function Formulation	8
3	• Three Phase Salient Pole Synchronous Machine • Parks Transformation, Steady State Analysis	8
4	• Large Signal Transient • Small Oscillation Equations in State Variable form • Dynamical Analysis of Interconnected Machines	8
5	• Large Signal Transient Analysis using Transformed Equations • DC Generator /DC Motor System	6
6	• Alternator /Synchronous Motor System	6

Suggested reading

1. D.P. Sengupta& J.B. Lynn," Electrical Machine Dynamics", The Macmillan Press Ltd. 1980
2. R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001
3. P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company,1987

. Boldia& S.A. Nasar,,"Electrical Machine Dynamics", The Macmillan Press Ltd. 1992

C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967

Course Outcomes: -

Students will be able to:

1:Formulation of electrodynamic equations of all electric machines and analyze the performance characteristics

2: Knowledge of transformations for the dynamic analysis of machines

3: Knowledge of determination of stability of the machines under small signal and transient conditions

4: Study about synchronous machine

PE 3 : POWER APPARTUS DESIGN

Course Objectives: -Students will be able to:
1. Study the modelling analysis of rotating machine.
2. Learning electromagnetic energy conversion
3. To know about rating of machines.

SYLLABUS

Units	Content	Hours
1	• Principles of Design of Machines -Specific loadings, choice of magnetic and electric loadings • Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines • Induction machines and synchronous machines • Design of Transformers-General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling	8
2	• Specific loadings, choice of magnetic and electric loadings Real and apparent flux -densities, temperature rise calculation • Separation of main dimension for DC machines • Induction machines and synchronous machines • Heating and cooling of machines, types of ventilation, continuous and intermittent rating	8
3	• General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes • Calculation of losses, efficiency and regulation • Forces winding during short circuit	8
4	• General considerations, output equation • Choice of specific electric and magnetic loadings, efficiency, power factor • Number of slots in stator and rotor • Elimination of harmonic torques	8
5	• Design of stator and rotor winding, slot leakage flux • Leakage reactance, equivalent resistance of squirrel cage rotor, Magnetizing current, efficiency from design data	6
6	• Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions • Introduction to Computer Aided Electrical Machine Design Energy efficient machines	6

Suggested reading

1. Clayton A.E, "The Performance and Design of D.C. Machines", Sir I. Pitman & sons, Ltd.
2. M.G. Say, "The Performance and Design of A.C. Machines ", Pitman
3. Sawhney A.K, "A course in Electrical Machine Design", DhanpatRai & Sons, 5th Edition

Course Outcomes: -

Students will be able to:

1. To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used
2. Ability to model and design all types of rotation machines including special machines

PE4 : ADVANCED MICRO-CONTROLLER BASED SYSTEMS

Course Objectives:-Students will be able to:

1. To understand the architecture of advance microcontrollers
2. To understand the applications of these controllers
3. To get some introduction to FPGA

Syllabus

Units	Content	Hours
1	• Basic Computer Organization • Accumulator based Processes-Architecture • Memory Organization-I/O Organization	8
2	• Micro-Controllers-Intel 8051, • Intel 8056- Registers, Memories • I/O Ports, Serial Communication • Timers, Interrupts, Programming	8
3	• Intel 8051 – Assembly language programming • Addressing-Operations • Stack & Subroutines • Interrupts-DMA	8
4	• PIC 16F877- Architecture Programming • Interfacing Memory/ I/O Devices • Serial I/O and data communication	8
5	• Digital Signal Processor (DSP) • Architecture – Programming • Introduction to FPGA	6
6	• Microcontroller development for motor control applications • Stepper motor control using micro controller	6

Suggested reading

1. John.F.Wakerly: "Microcomputer Architecture and Programming", John Wiley and Sons 1981
2. Ramesh S.Gaonker: "Microprocessor Architecture, Programming and Applications with the 8085",Penram International Publishing (India), 1994
3. Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005
4. Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004
5. John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005
6. Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F
Series", Elsevier, 2008
7. Microchip datasheets for PIC16F877

Course Outcomes: -

Students will be able to:

1. To learn how to program a processor in assembly language and develop an advanced processorbased system
2. To learn configuring and using different peripherals in a digital system
3. To compile and debug a Program
4. To generate an executable file and use it

PE 4 : SCADA SYSTEM AND APPLICATIONS

Course Objectives:-Students will be able to:
1. To understand what is meant by SCADA and its functions
2. To know SCADA communication
3. To get an insight into its application

Syllabus		
Units	**Content**	**Hours**
1	• Introduction to SCADA • Data acquisition systems • Evolution of SCADA • Communication technologies	8
2	• Monitoring and supervisory functions • SCADA applications in Utility Automation • Industries SCADA	6
3	• Industries SCADA System Components • Schemes- Remote Terminal Unit (RTU) • Intelligent Electronic Devices(IED) • Programmable Logic Controller (PLC) • Communication Network, SCADA Server, SCADA/HMI Systems	8
4	• SCADA Architecture • Various SCADA architectures, advantages and disadvantages of each system • single unified standard architecture -IEC 61850.	8
5	• SCADA Communication • various industrial communication technologies • wired and wireless methods and fiber optics • Open standard communication protocols	8
6	• SCADA Applications: Utility applications • Transmission and Distribution sector operations, monitoring, analysis and improvement • Industries - oil, gas and water	6
	• Case studies, Implementation, Simulation Exercises	

Suggested reading

1. Stuart A. Boyer: “SCADA-Supervisory Control and Data Acquisition”, Instrument Society of America
Publications,USA,2004
2. Gordon Clarke, Deon Reynders: “Practical Modern SCADA Protocols: DNP3, 60870.5 and Related
Systems”, Newnes Publications, Oxford, UK,2004
3. William T. Shaw, “Cybersecurity for SCADA systems”, PennWell Books, 2006
4. David Bailey, Edwin Wright, “Practical SCADA for industry”, Newnes, 2003
5. Michael Wiebe, “A guide to utility automation: AMR, SCADA, and IT systems for electric power”, PennWell 1999

Course Outcomes:-
Students will be able to:
1Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications

2Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
3 Knowledge about single unified standard architecture IEC 61850
4: To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server
6: Learn and understand about SCADA applications in transmission and distribution sector, industries etc

PE 4: POWER QUALITY

Course Objectives: -Students will be able to:
1. Understand the different power quality issues to be addressed
2. Understand the recommended practices by various standard bodies like IEEE,IEC, etc on voltage& frequency, harmonics
3. Understanding STATIC VAR Compensators

Syllabus

Units	Content	Hours
1	• Introduction-power quality-voltage quality-overview of power quality phenomena • classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C • message weights-flicker factor transient phenomena-occurrence of power quality problems • power acceptability curves-IEEE guides, standards and recommended practices.	8
2	• Harmonics-individual and total harmonic distortion • RMS value of a harmonic waveform- • Triplex harmonics-important harmonic introducing devices-SMPS- • Three phase power converters- • arcing devices saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.	8
3	• Modeling of networks and components under non-sinusoidal conditions transmission and distribution systems • Shunt capacitors-transformers-electric machines-ground • systems loads that cause power quality problems • power quality problems created by drives and its impact on drive	8
4	• Power factor improvement- Passive Compensation • Passive Filtering , Harmonic • Resonance • Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End, • Control Methods for Single Phase APFC • Three Phase APFC and Control Techniques, PFC • Based on Bilateral Single Phase and Three Phase Converter	8

5	• Static VAR compensators-SVC and STATCOM Active Harmonic Filtering-Shunt Injection • Filter for single phase, three-phase three-wire and three-phase four-wire systems • d-q domain control of three phase shunt active filters uninterruptible power supplies constant voltage • transformers • series active power filtering techniques for harmonic cancellation and isolation.	8
6	• Dynamic Voltage Restorers for sag , swell and flicker problems. Grounding and wiring introduction • NEC grounding requirements-reasons for grounding • typical grounding and wiring problems solutions to grounding and wiring problems	8

Suggested reading

1. G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007
2. Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000
3. J. Arrillaga, "Power System Quality Assessment", John wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,"Power system Harmonic Analysis", Wiley, 1997

Course Outcomes: -

Students will be able to:
1: Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads
2: To develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components
3: To introduce the student to active power factor correction based on static VAR compensators and its control techniques
4: To introduce the student to series and shunt active power filtering techniques for harmonics.

PE 4 – ARTIFICIAL INTELLIGENCE TECHNIQUES

Course Objectives:-Students will be able to:
1. Understanding fuzzy logic, ANN
2. Understanding GA & EP

Syllabus

Units	Content	Hours
1	• Biological foundations to intelligent Systems • Artificial Neural Networks, Single layer and Multilayer Feed Forward NN • LMS and Back Propagation Algorithm • Feedback networks and Radial Basis Function Networks	8
2	• Fuzzy Logic • Knowledge Representation and Inference Mechanism • Defuzzification Methods	8

3	• Fuzzy Neural Networks • some algorithms to learn the parameters of the network like GA	8
4	System Identification using Fuzzy and Neural Network	6
5	• Genetic algorithm • Reproduction cross over, mutation • Introduction to evolutionary program	8
6	Applications of above mentioned techniques to practical problems	6

Suggested reading

1. J M Zurada , "An Introduction to ANN",Jaico **Publishing** House
2. Simon Haykins, "Neural Networks", Prentice Hall
3. Timothy Ross, "Fuzzy Logic with Engg.Applications", McGraw. Hill
4. Driankov, Dimitra, "An Introduction to Fuzzy Control", Narosa Publication
5. Golding, "Genetic Algorithms", Addison-Wesley **Publishing** Com

Course Outcomes: -

Students will be able to:

1. Learn the concepts of biological foundations of artificial neural networks
2. Learn Feedback networks and radial basis function networks and fuzzy logics
3. Identifications of fuzzy and neural network
4. Acquire the knowledge of GA

LAB 3-POWER SYSTEM PROTECTION LAB /POWER QUALITY LAB

S.No	**List of experiments:**
1	Introduction to Power System Protection
2	Impact of Induction Motor Starting on Power System
3	Modelling of Differential Relay using MATLAB
4	Radial Feeder Protection
5	Parellel Feeder Protection
6	Principle of Reverse Power Protection
7	Differential Protection of Transformer
8	To the study time vs.voltage characteristcs of over voltage induction relay

LAB 4- Renewable Energy System Laboratory

S. No	List of experiments:
1	Characteristics of solar PV Modules connected in series and Parallel.
2	Effect of partial shading and the usage of bypass, blocking diodes.
3	Power flow calculations of stand-alone PV system on DC load, AC load with battery.
4	Charging and discharging characteristics of battery.
5	Maximum power point tracking (MPPT) by varying the duty cycle of DC-DC converter.
6	Observation of Vm, Im, Pm and duty cycle at MPP using MPP algorithm.
7	Observation of the inverter output voltage waveforms with 120 degree and 180 degree conduction mode with microcontroller.
8	Determination of Turbine Power versus Wind Speed Curve
9	Study of Wind Energy system performance through Wind Emulator.
10	Study of power quality in PCC when interfacing solar PV system with Grid.

THIRD SEMESTER

PE 5: POWER SYSTEM TRANSIENTS

Course Objectives: -Students will be able to:
1. Learn the reasons for occurrence of transients in a power system
2. Understand the change in parameters like voltage & frequency during transients
3. To know about the lightning phenomenon and its effect on power system

Syllabus

Units	Content	Hours
1	• Fundamental circuit analysis of electrical transients • Laplace Transform method of solving simple Switching transients • Damping circuits -Abnormal switching transients, Three-phase circuits and transients • Computation of power system transients	8

2	• Principle of digital computation – Matrix method of solution • Modal analysis- Z transform- Computation using EMTP • Lightning, switching and temporary over voltages, Lightning • Physical phenomena of lightning.	8
3	• Interaction between lightning and power system • Influence of tower footing resistance and Earth Resistance • Switching: Short line or kilometric fault • Energizing transients - closing and • re-closing of lines • line dropping, load rejection – over voltages induced by faults	8
4	• Switching HVDC lineTravelling waves on transmission line • Circuits with distributed Parameters Wave Equation • Reflection, Refraction, Behaviour of Travelling waves at the line terminations • Lattice Diagrams – Attenuation and Distortion • Multi-conductor system • and Velocity wave	**8**
5	• Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS) Co-ordination between insulation and protection level • Statistical approach	**6**
6	• Protective devices • Protection of system against over voltages • lightning arresters, substation earthling	**6**

Suggested reading

1. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 1991

Course Outcomes: -

Students will be able to:

1: Knowledge of various transients that could occur in power system and their mathematical formulation

2: Ability to design various protective devices in power system for protecting equipment and personnel

3: Coordinating the insulation of various equipments in power system

4: Modelling the power system for transient analysis

PE 5:FACTS AND CUSTOM POWER DEVICES

Course Objectives:-Students will be able to: 1. To learn the active and reactive power flow control in power system 2. To understand the need for static compensators 3. To develop the different control strategies used for compensation		
Syllabus		
Units	**Content**	**Hours**

1	• Reactive power flow control in Power Systems • Control of dynamic power unbalances in Power System - Power flow control • Constraints of maximum transmission line loading • Benefits of FACTS Transmission line compensation • Uncompensated line -Shunt compensation, Series compensation Phase angle control • Reactive power compensation Shunt and Series compensation principles • Reactive compensation at transmission and distribution level	8
2	• Static versus passive VAR compensator, • Static shunt compensators: SVC and • STATCOM • Operation and control of TSC, TCR and STATCOM -Compensator control • Comparison between SVC and STATCOM	8
3	• Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators • TCVR and TCPAR Operationand Control • Applications, Static series compensation • GCSC,TSSC, TCSC and Static synchronous series compensators and their Control	8
4	• SSR and its dampingUnified Power Flow Controller • Circuit Arrangement, Operation • and control of UPFC • Basic Principle of P and Q control • Independent real and reactivepower flow control- Applications.	8
5	• Introduction to interline power flow controller. • Modeling and analysis of FACTS • Controllers • Simulation of FACTS controllers Power quality problems in distribution systems, • harmonics, loads that create harmonics • modeling, harmonic propagation, series and parallel resonances mitigation of harmonics • passive filters, active filtering – shunt , series and hybrid and their	6
	control	
6	• Voltage swells , sags, flicker, unbalance and mitigation of these problems by power line conditioners • IEEE standards on power quality.	6

Suggested reading

1. K R Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age InternationalPublishers, 2007

2. X P Zhang, C Rehtanz, B Pal, “Flexible AC Transmission Systems- Modelling and Control”, SpringerVerlag, Berlin, 2006

3. N.G. Hingorani, L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible ACTransmission Systems”, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.

4. K.S.Sureshkumar ,S.Ashok , “FACTS Controllers & Applications”, E-book edition, Nalanda

DigitalLibrary, NIT Calicut,2003
5. G T Heydt , “Power Quality”, McGraw-Hill Professional, 2007
6. T J E Miller, “Static Reactive Power Compensation”, John Wiley and Sons, Newyork, 1982.

Course Outcomes: -

Students will be able to:

1. Acquire knowledge about the fundamental principles of Passive and Active Reactive PowerCompensation Schemes at Transmission and Distribution level in Power Systems.
2.Learn various Static VAR Compensation Schemes like Thyristor/GTOControlled Reactive Power Systems, PWM_Inverter based Reactive Power Systems andtheircontrols.
3. To develop analytical modeling skills needed for modeling and analysis of such Static VARSystems.

PE 5:IDUSTRIAL LOAD MODELING AND CONTROL

Course Objectives:-Students will be able to:

1. To understand the energy demand scenario
2. To understand the modeling of load and its ease to study load demand industrially
3. To know Electricity pricing models
4. Study Reactive power management in Industries

Syllabus

Units	Content	Hours
1	• Electric Energy Scenario-Demand Side Management-Industrial Load Management • Load Curves-Load Shaping Objectives • Methodologies-Barriers • Classification of Industrial • Loads • Continuous and Batch processes -Load Modeling	8
2	• Electricity pricing – Dynamic and spot pricing -Models • Direct load control- Interruptible load control • Bottom up approach- scheduling- Formulation of load • Models • Optimization and control algorithms - Case studies	8
3	• Reactive power management in industries • controls-power quality impacts • application of filters Energy saving in industries	8
4	• Cooling and heating loads	8
	• load profiling • Modeling- Cool storage • Types-Control strategies • Optimal operation • Problem formulation- Case studies	

5	• Captive power units • Operating and control strategies • Power Pooling- Operation models • Energy banking • Industrial Cogeneration	6
6	• Selection of Schemes Optimal Operating Strategies • Peak load saving • Constraints Problem formulation- Case study • Integrated Load management for Industries	6

Suggested reading

1. C.O. Bjork " Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989
2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981
4. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 1989.
5. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995
6. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA

Course Outcomes: -

Students will be able to:
1: Knowledge about load control techniques in industries and its application
2: Learn different types of industrial processes and optimize the process using tools like LINDO and LINGO
3: Apply load management to reduce demand of electricity during peak time
4: Apply different energy saving opportunities in industries

PE 5: DYNAMICS OF LINEAR SYSTEMS

Course Objectives:-Students will be able to:
1. To understand the linear system and its functions
2. To understand the stability analysis of linear systems and implement the same in MATLAB

Syllabus

Units	Content	Hours
1	• State variable representations of systems • transfer function and transfer function matrix • solutions of state equations	8
2	• Observability and controllability • minimal realization of MIMO systems • analysis of linear time varying systems • the concepts of stability	8
3	• Lyapunov stability analysis • Lyapunov function and its properties • controllability by state variable feedback	8

4	• Ackerman's Formula - stabilisation by output feedback • asymptotic observers for state measurement • observer design	6
5	• State space representation of discrete systems • solution of state equations, controllability and observabilty stability analysis using Lyapunov method	6
6	• State feedback of linear discrete timesystems • design of observers - MATLAB Exercises	8

Suggested reading

1. Thomas Kailath, "Linear Systems", Prentice Hall Inc., Englewood Cliffs, N.J. 1980.
2. K. Ogata, "State Space Analysis of Control Systems", Prentice Hall Inc., Englewood Cliffs, N.J., 1965.
3. K. Ogata, "Modern Control Engineering, (second edition)" , Prentice Hall Inc., Englewood Cliffs, N.J., 1990
4. M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
5. C.T. Chen, "Linear System Theory and Design", New York: Holt Rinehart and Winston ,1984
6. R.C. Dorf, and R. T. "Bishop, Modern Control Systems", Addison Wesley Longman Inc., 1999.

Course Outcomes:-

Students will be able to:

1: To learn linear system modeling, analysis and design so as to obtain theability to apply the same to engineering problems in a global perspective

2: Knowledge on carrying out detailed stability analysis of both linear and nonlinear systems

3: Design observers and controllers for linear systems

4: Acquire knowledge of discrete time linear systems modeling, analysis and design

5: Develop and utilize modern software tools for analysis and designof linear continuous and discrete time systems

PE 6: POWER SEMICONDUCTOR DEVICES AND MODELING

Course Objectives:-Students will be able to:

1. Understand the basic operation and I-V characteristics of various power semiconductor devices
2. Study the circuit model of various devices
3. Understand the protection and control circuit for these semiconductor devices

Syllabus

Units	Content	Hours
1	• Energy auditing: Types and objectives - audit instruments- ECO assessment • Economic methods specific energy analysis • Minimum energy paths-consumption models- Case study	8
2	• Electric motors-Energy efficient controls and starting efficiency • Motor Efficiency and Load Analysis- Energy efficient /high efficient Motors-Case study • Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies	8
	• Optimalselection and sizing – Optimal operation and Storage; Case study	

3	• Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, Case study • Reactive Power management-Capacitor Sizing-Degree of Compensation-Capacitor losses • Location-Placement Maintenance, Case study	8
4	• Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load • scheduling-case study • Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes • Electronic ballast-Power quality issues-Luminaries, Case study	8
5	• Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study • Electric loads of Air conditioning & Refrigeration-Energy conservation measures- Cool storage types Optimal operation case study	6
	• Electric water heating-Gysers-Solar Water Heaters • Power Consumption in Compressors • Energy conservation measures Electrolytic Process • Computer Controls- software – EMS	8

Suggested reading

1. Giovanni Petrecca, "Industrial Energy Management: Principles and Applications", The Kluwerinternational series -207, 1999
2. Anthony J. Pansini, Kenneth D. Smalling, "Guide to Electric Load Management", Pennwell Pub; (1998)
3. Handbook on Energy Audit and Environment Management , Y P Abbi and Shashank Jain, TERI, 2006
4. Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009

Course Outcomes:-

Students will be able to:
1. Acquire the background required for engineers to meet the role of energy managers and to acquire the skills and techniques required to implement energy management
2. Identify and quantify the energy intensive business activities in an organization
3.Knowledge about standard methodologies for measuring energy in the workplace and energy audit instruments
4.Knowledge about energy efficient motors, load matching and selection of motors
5. Acquire knowledge about reactive power management, capacitor sizing and degree of Compensation

PE 6:ENGINEERING OPTIMIZATION

Course Objectives:-Students will be able to: 1. To understand the need for optimization and different techniques involved and also constraints. 2. To know Linear/Non-linear Programming. 3. To understand the importance of optimization to solve Engineering problems
4. To know genetic algorithm for Engineering Optimization
Syllabus

Units	Content	Hours
1	• Concepts of optimization: Engineering applications • Statement of optimization • Problem • Classification - type and size of the problem • Classical Optimization Techniques: Single and multi variable problems- Types of Constraints • Semi definite case-saddle point	8
2	• Linear programming: Standard form-Geometry of LP problems-Theorem of LP • Relation to convexity - formulation of LP problems - simplex method and algorithm • Matrix form- two phase method. Duality • dual simplex method- LU Decomposition	8
3	• Sensitivity analysis .Artificial variables and complementary solutions- QP. • Engineering Applications:Minimum cost flow problem • Network problems-transportation, • assignment & allocation, scheduling • Karmarkar method-unbalanced and routing problems.	8
4	• Nonlinear programming: Non linearity concepts-convex and concave functions • non-linear programming -gradient and Hessian. Unconstrained optimization • First & • Second order necessary conditions- Minimisation & Maximisation • Local & Global convergence- • Speed of convergence	6
5	• Basic decent methods: Fibonacci & Golden section search - Gradient methods - Newton • Method-Lagrange multiplier method - Kuhn-tucker conditions • Quasi-Newton method- separable • convex programming -Frank and Wolfe method, Engineering Applications • Nonlinear programming- Constrained optimization: Characteristics of constraints-Direct methods- SLP,SQP-Indirect • Methods. • Transformation techniques-penalty function-Langrange multiplier methods checking convergence- Engineering applications	8
6	• Dynamic programming: Multistage decision process- Concept of sub optimization and principle • Of optimality • Computational procedure- Engineering applications. Genetic algorithms- Simulated • Annealing Methods - Optimization programming, tools and Software	6
	packages	

Suggested reading

1. David G Luenberger, “Linear and Non Linear Programming”, 2nd Ed, Addison-Wesley Pub.Co.,Massachusetts, 2003
2. W.L.Winston, “Operation Research-Applications & Algorithms”,2nd Ed., PWS-KENT Pub.Co.,Boston, 2007
3. S.S.Rao, “Engineering Optimization”, 3rd Ed.,New Age International (P) Ltd,New Delhi, 2007
4. W.F.Stocker, “Design of Thermal Systems”, 3rd Ed., McGraw Hill, New York. 1990
5. G.B.Dantzig, “Linear Programming and Extensions” Princeton University Press, N.J., 1963.
6. L.C.W.Dixton, ”Non Linear Optimisation: theory and algorithms” Birkhauser, Boston, 1980

Course Outcomes:-

Students will be able to:

1: Apply optimization techniques to typical engineering problems
2: Learn the concepts and techniques of nonlinear and unconstrained optimization
3: Acquire knowledge on direct and indirect methods for constrained optimization
4: Learn the application of dynamic programming and genetic algorithms for engineering Optimization

PE 6: HIGH VOLTAGE ENGINEERING

Course Objectives:-Students will be able to:
1. To get introduced to high voltage engineering
2. To understand different high voltage measurements and the necessary instruments

Syllabus

Units	Content	Hours
1	• Voltage doubler - cascade circuits • electrostatic machines	6
2	• Generation of Impulse voltages and curreningle stage and multistage circuits • wave shaping-tripping and control of impulse generators	8
3	• Generation of switching surge voltage and impulse current Measurement of high • voltages and currents • DC,AC and impulse voltages and currents • DSO-electrostatic and peak • Voltmeters sphere gaps-factors affecting measurements-potential dividers(capacitive and resistive) ries impedance ammeters-rogowski coils-hall effect generators • Digital techniques in HV measurements	8
4	• Measurement of electric field, Sources of EMI • Principles of EMC, Filtering, Shielding • Grounding techniques	8
5	• Introduction to relevant national and international standards • Layout and clearances as • well as shielding and grounding of HV lab	8

6	• Safety regulations for high voltage tests, Calibration of HV measuring instruments • Indian Standards for HV clearances. Recent trends in HV Engineering	8

Suggested reading

1. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", McGraw-Hill, 1995.
2. M. Khalifa, "High Voltage Engineering: Theory and Practice", Dekker, 1990
3. H. M. Ryan, "High Voltage Engineering and Testing", Peter Peregrinus, 1994
4. Wadhwa C L."High Voltage Engineering", Wiley Eastern Limited, NewDelhi,1994
5. Ott, H.W.,"Noise Reduction Techniques in Electronic Systems", John Wiley, New York, 1989

Course Outcomes:-

Students will be able to:
1. Knowledge about the need for high voltage generation
2. Acquaint with the different methods for generating high voltage AC/DC and impulse voltages and current
3. Knowledge about the measurement techniques for high voltage AC/DC and impulsevoltages and currents
4. To learn sources of EMI and its mitigation techniques
5. Safety precautions to be taken while designing an HV lab

OE -ENERGY AUDITING AND MANAGEMENT

Course Objectives:-Students will be able to:
1. To understand the need for energy auditing
2. Understanding of various loads involved based on power consumption for auditing
3. To know about different audit instruments used in practice

Syllabus

Units	Content	Hours
1	• System approach and End use approach to efficient use of Electricity • Electricity tariff types • Energy auditing: Types and objectives - audit instruments • ECO assessment and Economic methods • Specific energy analysis-Minimum energy paths-consumption models-Case study	6
2	• Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load • Analysis Energy efficient /high efficient Motors-Case study • Load Matching and selection of motors • Variable speed drives; Pumps and Fans-Efficient Control strategies-Optimal selection and sizing • Optimal operation and Storage; Case study	8

3	• Transformer Loading/Efficiency analysis • Feeder/cable loss evaluation, case study • Reactive Power management-Capacitor • Sizing-Degreeof Compensation-Capacitor losses • Location-Placement • Maintenance ,Case study	8
4	• Peak Demand controls- Methodologies • Types of Industrial loads-Optimal Load • scheduling-case study • Lighting- Energy efficient light sources-Energy conservation in Lighting	8
	• Schemes • Electronic ballast-Power quality issues-Luminaries, case study	
5	• Cogeneration-Types and Schemes • Optimal operation of cogeneration plants-case study • Electric loads of Air conditioning &Refrigeration • Energy conservation measures- Cool storage • Types-Optimal operation case study	8
6	• Electric water heating- • Geysers-Solar Water Heaters • Power Consumption in Compressors • Energy conservation measures • Electrolytic Process • Computer Controls- software-EMS	6

Suggested reading

1. Anthony J. Pansini, Kenneth D. Smalling, .Guide to Electric Load Management., Pennwell Pub; (1998)
2. Howard E. Jordan, .Energy-Efficient Electric Motors and Their Applications., Plenum Pub Corp; 2ndedition (1994)
3. Giovanni Petrecca, .Industrial Energy Management: Principles and Applications., The Kluwerinternational series -207,1999
4. Handbook on Energy Audit and Environment Management , Y P Abbi and Shashank Jain, TERI,2006
5. Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009

Course Outcomes:-Students will be able to:

1. Acquire the background required for engineers to meet the role of energy managers and to acquire the skills and techniques required to implement energy management
2. Identify and quantify the energy intensive business activities in an organization
3. Able to perform Basic Energy Audit in an Organization

OPEN ELECTIVES

Business Analytics

Teaching scheme

Lecture: - 3 h/week

Course Code	
Course Name	**Business Analytics**
Credits **Prerequisites**	

Total Number of Lectures: 48

Course objective
1. Understand the role of business analytics within an organization. 2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization. 3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making. 4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques. 6. Mange business process using analytical and management tools. 7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	9
Unit 2: Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	8
Unit 3: Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	9

Unit 4: Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	10
Unit 5: Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	8
Unit 6: Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	4
COURSE OUTCOMES	
1. Students will demonstrate knowledge of data analytics. 2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics. 3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making. 4. Students will demonstrate the ability to translate data into clear, actionable insights.	

Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

OPEN ELECTIVES
Industrial Safety

Teaching scheme

Lecture: - 3 h/week

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 color codes. Fire prevention and firefighting, 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 treeconcept, 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

Reference:

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.

OPEN ELECTIVES
Operations Research

Teaching Scheme

Lectures: 3 hrs/week

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.

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 simplex method - sensitivity analysis - parametric programming

Unit 3:

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

Unit 4

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - 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

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 Optimisation: 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

Open Elective
Cost Management & Engineering Projects

Teaching scheme

Lecture: - 3 h/week

Introduction and Overview of the Strategic Cost Management Process

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution : conception to commissioning. Project execution as conglomeration of technical and non

technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team : Role of each member. Importance Project site : Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of CostAccounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Open Elective
Composite Materials

Teaching scheme

Lecture: - 3 h/week

UNIT–I: INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT – II: REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT – III: Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–IV: Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT – V: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

REFERENCES:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Open Elective
Waste to Energy

Teaching scheme

Lecture: - 3 h/week

Unit-I: Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit-II: Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit-III: Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit-IV: Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit-V: Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

AUDIT 1 and 2: ENGLISH FOR RESEARCH PAPER WRITING

Course objectives:

Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title

Ensure the good quality of paper at very first-time submission

Syllabus

Units	CONTENTS	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	4
6	useful phrases, how to ensure paper is as good as it could possibly be the	4

	first- time submission	

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

UDIT 1 and 2: DISASTER MANAGEMENT

Course Objectives:-Students will be able to:

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus

Units	CONTENTS	Hours
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4
6	**Disaster Mitigation**	4

	Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	***Content***	***Hours***
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	• Technical concepts of Engineering-Electrical,Mechanical, Architecture, Mathematics	8

Suggested reading

1. "Abhyaspustakam" – Dr.Vishwas, Sanskrit-Bharti Publication,New Delhi

2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood

3. Being a logical language will help to develop logic in students

AUDIT 1 and 2: VALUE EDUCATION

Course Objectives

Students will be able to

1. Understand value of education and self- development

2. Imbibe good values in students

3. Let the should know about the importance of character

Syllabus

Unit	***Content***	***Hours***
1	• Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles. • Value judgements	4
2	• Importance of cultivation of values. • Sense of duty. Devotion, Self-reliance.Confidence,Concentration.Truthfulness, Cleanliness. • Honesty ,Humanity.Power of faith, National Unity. • Patriotism.Love for nature ,Discipline	6
3	• Personality and Behaviour Development - Soul and Scientific attitude.Positive Thinking.Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labour. • Universal brotherhood and religious tolerance. • True friendship. • Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. • Doing best for saving nature	6
4	• Character and Competence –Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality ,Non violence ,Humility, Role of Women. • All religions and same message. • Mind your Mind ,Self-control. • Honesty, Studying effectively	6

Suggested reading

1 Chakroborty , S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press ,New Delhi

Course outcomes

Students will be able to

1.Knowledge of self-development 2.Learn the importance of Human values

3.Developing the overall personality

AUDIT 1 and 2: CONSTITUTION OF INDIA

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus

Units	Content	Hours
1	• **History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)	4
2	• **Philosophy of the Indian Constitution:** Preamble Salient Features	4
3	**Contours of Constitutional Rights & Duties:** Fundamental Rights Right to Equality Right to Freedom Right against Exploitation Right to Freedom of Religion Cultural and Educational Rights Right to Constitutional Remedies Directive Principles of State Policy Fundamental Duties.	4
4	**Organs of Governance:** Parliament Composition Qualifications and Disqualifications Powers and Functions • Executive President Governor Council of Ministers	4

	• Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions	
5	**Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	4
6	**Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	4

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

AUDIT 1 and 2: PEDAGOGICAL STUDIES

Course Objectives:

Students will be able to:

4. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
5. Identify critical evidence gaps to guide the development.

Syllabus

Units	Content	Hours
1	**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.	4

2	• Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education.	2
3	□ Evidence on the effectiveness of pedagogical practices □ Methodology for the in depth stage: quality assessment of included studies. □ How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? □ Theory of change. □ Strength and nature of the body of evidence for effective pedagogical practices. □ Pedagogic theory and pedagogical approaches. □ Teachers' attitudes and beliefs and Pedagogic strategies.	4
4	• Professional development: alignment with classroom practices and follow-up support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes	4
5	□ **Research gaps and future directions** □ Research design □ Contexts □ Pedagogy □ Teacher education □ Curriculum and assessment □ Dissemination and research impact.	2

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

Syllabus

Unit	*Content*	*Hours*
1	• Definitions of Eight parts of yog. (Ashtanga)	8
2	• Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	• Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayam	8

Suggested reading

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur

2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also

2. Improve efficiency

AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE and ENLIGHTENMENT SKILLS

Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Syllabus

Unit	Content	Hours

1	Neetisatakam-Holistic development of personality • Verses- 19,20,21,22 (wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65 (virtue) • Verses- 52,53,59 (dont's) • Verses- 71,73,75,78 (do's)	8
2	• Approach to day to day work and duties. • Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, • Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, • Chapter 18-Verses 45, 46, 48.	8
3	• Statements of basic knowledge. • Shrimad Bhagwad Geeta : Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18 • Personality of Role model. Shrimad Bhagwad Geeta : Chapter2-Verses 17,Chapter 3-Verses 36,37,42, • Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63	8

Suggested reading

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata

2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life

2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity

3. Study of Neetishatakam will help in developing versatile personality of students.