Annexure-1

Scheme & Syllabus of

Master of Technology
(Power and Energy System)

Batch 2024 & Onwards

By

Board of Studies Electrical Engineering

Department of Academics

I.K. Gujral Punjab Technical University Jalandhar

Master of Technology in

(Power and Energy System)

Board of Studies for PG studies in Electrical Engineering, Electrical and Electronics Engineering, Electronics and Electrical Engineering
IK Gujral Punjab Technical University Main Campus
28th May, 2024

It is a Post Graduate (PG) Programme of 2 years duration (4 semesters). Additional Lectures/ Tutorials: Need based additional Lectures/ Tutorials may be introduced for any course, however the credits of the course will not change.

Courses & Examination Scheme:

First Semester

Course Code	Course Type	Course Name	L	T	P	Marks Distribution		Total Marks	Credits
						Internal	External		
PES-101/24	Core 1 Theory	Computer Aided Power System Analysis	4	0	0	40	60	100	4
PES-102/24	Core 2 Theory	Distributed Generation	4	0	0	40	60	100	4
PES-103X/24	PE1	Professional Elective-1	3	0	0	40	60	100	3
PES-104Y/24	PE2	Professional Elective-2	3	0	0	40	60	100	3
MTRM-101/18	-	Research Methodology and IPR	2	0	0	40	60	100	2
PES-105/24	Practical/ Laboratory 1	Power System Analysis Lab	0	0	4	60	40	100	2
PES-106/24	Practical/ Laboratory 2	Power System Lab-1	0	0	4	60	40	100	2
MTA-10X/18	Audit-1	Audit Course-1	2	0	0	00	00	S/ US*	Non-Credit
Total			**18**	**0**	**8**	**320**	**380**	**700**	**20**

S/US*: Satisfactory/Un-Satisfactory

Professional Elective/ Audit	Course Code	Course Name	L	T	P	Marks Distribution		Total Marks	Credits
						Internal	External		
PE1	PES-103A/24	FACTS and Custom Power Devices	3	0	0	40	60	100	3
	PES-103B/24	Advanced Power System Protection	3	0	0	40	60	100	3
	PES-103C/24	Mathematical Methods for Power Engineering	3	0	0	40	60	100	3
	PES-103D/24	Analysis of Power Converter	3	0	0	40	60	100	3
PE2	PES-104A/24	Rural Energy Systems and Sustainable Development	3	0	0	40	60	100	3
	PES-104B/24	Waste to Energy Conversion Technologies	3	0	0	40	60	100	3
	PES-104C/24	Small Hydro and Non-Conventional Technologies	3	0	0	40	60	100	3
	PES-104D/24	Solar Energy Conversion Technologies	3	0	0	40	60	100	3
Audit-1	MTA-101/18	English for Research Paper Writing	2	0	0	00	00	S/US*	Non-Credit
	MTA-102/18	Disaster Management	2	0	0	00	00	S/US*	Non-Credit
	MTA-103/18	Sanskrit for Technical Knowledge	2	0	0	00	00	S/US*	Non-Credit
	MTA-104/18	Value Education	2	0	0	00	00	S/US*	Non-Credit

S/US*: Satisfactory/ Un-Satisfactory

Second Semester

Course Code	Course Type	Course Name	L	T	P	Marks Distribution		Total Marks	Credits
						Internal	External		
PES-201/24	Core 3 Theory	Renewable Distribution Systems	4	0	0	40	60	100	4
PES-202/24	Core 4 Theory	Power System Dynamics	4	0	0	40	60	100	4
PES-203X/24	PE3	Professional Elective-3	3	0	0	40	60	100	3
PES-204Y/24	PE4	Professional Elective-4	3	0	0	40	60	100	3
PES-205/24	Practical/ Laboratory 3	Mini Project	0	0	4	60	40	100	2
PES-206/24	Practical/ Laboratory 4	Seminar	0	0	2	100	--	100	1
PES-207/24	Practical/ Laboratory 5	Power System Lab-2	0	0	4	60	40	100	2
PES-208/24	Practical/ Laboratory 6	Renewable Energy Lab	0	0	4	60	40	100	2
MTA-10Y/18	Audit-2	Audit Course-2	2	0	0	00	00	S/US*	Non-Credit
Total			**16**	**0**	**14**	**440**	**360**	**800**	**21**

S/US*: Satisfactory/ Un-Satisfactory

Professional Elective/ Audit	Course Code	Course Name	L	T	P	Marks Distribution		Total Marks	Credits
						Internal	External		
PE3	PES-203A/24	Energy Conservation and Audit	3	0	0	40	60	100	3
	PES-203B/24	Advanced Power Systems Protection	3	0	0	40	60	100	3
	PES-203C/24	Reliability Analysis and Protection	3	0	0	40	60	100	3
	PES-203D/24	Energy Economics and Policies	3	0	0	40	60	100	3
PE4	PES-204A/24	Electric and Hybrid Vehicles	3	0	0	40	60	100	3
	PES-204B/24	Smart Grids	3	0	0	40	60	100	3
	PES-204C/24	Engineering Optimization	3	0	0	40	60	100	3
	PES-204D/24	Artificial Intelligence Techniques	3	0	0	40	60	100	3
Audit-2	MTA-105/18	Constitution of India	2	0	0	00	00	S/US*	Non-Credit
	MTA-106/18	Pedagogy Studies	2	0	0	00	00	S/US*	Non-Credit
	MTA-107/18	Stress Management By Yoga	2	0	0	00	00	S/US*	Non-Credit
	MTA-108/18	Personality Development through Life Enlightenment Skills	2	0	0	00	00	S/US*	Non-Credit

S/US*: Satisfactory/Un-Satisfactory

Third Semester

Core /Elective	Course Code	Course Name	L	T	P	Marks Distribution		Total Marks	Credits
						Internal	External		
PE5	PES-301X/24	Professional Elective-5	3	0	0	40	60	100	3
Open Elective	MTOE-301X/18	Open Elective	3	0	0	40	60	100	3
Major Project	PES-302/24	Phase-1 Dissertation	0	0	20	60	40	100	10
Total			**6**	**0**	**20**	**140**	**160**	**300**	**16**

Professional Elective /Audit	Course Code	Course Name	L	T	P	Marks Distribution		Total Marks	Credits
						Internal	External		
PE5	PES-301A/24	Industrial Load Modelling and Control	3	0	0	40	60	100	3
	PES-301B/24	Power System Deregulation	3	0	0	40	60	100	3
	PES-301C/24	Solar PV Energy System	3	0	0	40	60	100	3
	PES-301D/24	Power System Generation Control	3	0	0	40	60	100	3
OE	MTOE-301A/18	Business Analysis	3	0	0	40	60	100	3
	MTOE-301B/18	Industrial Safety	3	0	0	40	60	100	3
	MTOE-301C/18	Operations Research	3	0	0	40	60	100	3
	MTOE-301D/18	Cost Management of Engineering Projects	3	0	0	40	60	100	3
	MTOE-301E/18	Composite Materials	3	0	0	40	60	100	3
	MTOE-301F/18	Waste to Energy	3	0	0	40	60	100	3

Fourth Semester

Course Code	Course Type	Course Name	L	T	P	Marks Distribution		Total Marks	Credits
						Internal	External		
PES-401/24	Major Project	Phase-2 Dissertation	0	0	32	60	40	100	16
Total			**-**	**-**	**32**	**60**	**40**	**100**	**16**

Total Marks of M. Tech Program = 1900

Total Credits of M. Tech Program = 73

Programme Educational Objectives

I Core Competence: To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems and also to pursue higher studies.

II Breadth: To train students with good scientific and engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for the real-life problems.

III Professionalism: To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate engineering issues to broader social context.

Programme Specific Outcomes (PSOs)

PSO1 The ability to design a component, system or process related to Power and Energy System (PES) for a defined objective and conduct experiments, as well as to analyze data.

PSO2 An ability to design a component, system or process related to PES to meet desired needs within realistic constraints such as safety, environmental, economic, social, ethical, manufacturability and sustainability.

Programme Outcomes

PO1 An ability to independently carry out research/investigation and development work to solve practical problems.

PO2 An ability to write and present a substantial technical report/document.

PO3 Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Annexure - 2

PES-101/24 COMPUTER AIDED POWER SYSTEM ANALYSIS

L	T	P
4	0	0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: Understand various methods of load flow and their advantages and disadvantages
CO2: Analyze various types of faults in power system
CO3: Understand power system security concepts and rank the contingencies
CO4: Estimate closeness to voltage collapse and calculate PV curves.

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	10
2	AVR in load flow, handling of discrete variable in load flow, Fault Analysis: Simultaneous faults, open conductor faults, generalized method of fault analysis	12
3	Security Analysis: Security state diagram, contingency analysis, generator shift distribution factors	10
4	Line outage distribution factor, multiple line outages, overload index ranking	10
5	Power System Equivalents: WARD REI. equivalents, State Estimation: Sources of errors in measurement Virtual and Pseudo, Measurement, Observability, Tracking state estimation, WSL method, bad data correction Voltage Stability: Voltage collapse, P-V curve, multiple power flow solution, continuation power flow, optimal multipliers load flow, voltage collapse proximity indices	12

Suggested reading:

1. J.J. Grainger & W.D. Stevenson, "Power system analysis", McGraw Hill ,2003
2. A. R. Bergen & Vijay Vittal , "Power System Analysis", Pearson , 2000
3. L.P. Singh, "Advanced Power System Analysis and Dynamics", New Age International, 2006.
4. G.L. Kusic, "Computer aided power system analysis",Prentice Hall India, 1986.
5. J. Wood, "Power generation, operation and control", John Wiley, 1994.
6. P.M. Anderson, "Faulted power system analysis", IEEE Press , 1995

PES-102/24 **DISTRIBUTED GENERATION** **L T P**
Internal Marks: 40 **4 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: Understand the planning and operational issues related to Distributed Generation.
CO2: Analyse the impact of Distributed Generation
CO3: Understand the Micro-Grids
CO4: Analyse the micro-grids

Syllabus

Units	Content	Hours
1	Need for Distributed generation. Renewable sources in distributed generation and current scenario in Distributed Generation. Planning of DGs: Sitting and sizing of DGs optimal placement of DG sources in distribution systems. Grid integration of DGs Different types of interfaces, Inverter based DGs and rotating machine based interfaces. Aggregation of multiple DG units.	12
2	Technical impacts of DGs, Transmission systems Distribution Systems De-regulation Impact of DGs, upon protective relaying, Impact of DGs upon transient and dynamic stability of existing distribution systems, Steady-state and Dynamic analysis.	12
3	Economic and control aspects of DGs Market facts. Issues and challenges Limitations of DGs, Voltage control techniques. Reactive power control, Harmonics Power quality issues, Reliability of DG based systems.	12
4	Introduction to micro-grids. .Types of micro-grids: autonomous and non-autonomous grids Sizing of micro-grids. Modeling & analysis of Micro-grids with multiple DGs. Micro-grids with power electronic interfacing units. Transients in micro-grids, Protection of micro-grids, Case studies, Advanced topics.	12

Suggested reading:

1. H. Lee Willis, Walter G. Scott, "Distributed Power Generation – Planning and Evaluation",Marcel Decker Press.
2. M.GodoySimoes, Felix A.Farret, "Renewable Energy Systems – Design and Analysis with Induction Generators", CRC press.
3. Stuart Borlase. "Smart Grid: Infrastructure Technology Solutions" CRC Press.

Professional Electives for 1st Semester

Professional Elective	Course Code	Course Name
PE1	PES-103A/24	FACTS and custom Power Devices
	PES-103B/24	Advanced Power System Protection
	PES-103C/24	Mathematical Methods for Power Engineering
	PES-103D/24	Analysis of Power Converter
PE2	PES-104A/24	Rural Energy Systems and Sustainable Development
	PES-104B/24	Waste to Energy Conversion Technologies
	PES-104C/24	Small Hydro and Non-Conventional Technologies
	PES-104D/24	Solar Energy Conversion Technologies

PES-103A/24 **FACTS AND CUSTOM POWER DEVICES** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:

CO1: Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems.

CO2: Learn various Static VAR Compensation Schemes like Thyristor/GTO Controlled.

CO3: Reactive Power Systems, PWM Inverter based Reactive Power Systems and their controls.

CO4: To develop analytical modeling skills needed for modeling and analysis of such Static VAR Systems.

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 .	6
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. Static series compensation: TSSC, SSSC -Static voltage and phase angle. Regulators – TCVR and TCPAR Operation and Control-Applications, Static series compensation-GCSC, TSSC, TCSC and Static synchronous series compensators and their Control.	12
3	SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPF, Basic Principle of P and Q control- Independent real and reactive power flow control- Applications.	10
4	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 control. Voltage swells, sags, flicker, unbalance and mitigation of these problems By power line conditioners- IEEE standards on power quality.	12

Suggested reading:

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New
2. AgeInternationalPublishers, 2007.
3. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and
4. Control",Springer Verlag, Berlin, 2006.
5. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
6. K.S.Sureshkumar, S.Ashok , "FACTS Controllers & Applications", E-book edition, Nalanda
7. Digital Library, NIT Calicut, 2003.
8. G. T.Heydt, "Power Quality", McGraw-Hill Professional, 2007.
9. T. J. E. Miller, "Static Reactive Power Compensation", John Wiley and Sons, Newyork, 1982.

PES-103B/24 **ADVANCED POWER SYSTEM PROTECTION** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
1. Learn about classification and operation of static relays.
2. Understand the basic principles and application of comparators.
3. Understand static version of different types of relays.
4. Understand about numerical protection techniques.

Syllabus

Units	Content	Hours
1	Static Relays classification and Tools : Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.	9
2	Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators. Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.	9
3	Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings,	8
4	PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.	8
5	Microprocessor based relays and Numerical Protection: Introduction – over current relays – impedance relay – directional relay – reactance relay. Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mannmorrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.	8

Suggested Reading:

1. T.S.M. Rao, Power System Protection with Static Relays, TMH.
2. Badri Ram & D. N. viswakarma, Power system protection & switchgear, TMH.
3. Warrington Protective Relaying Vol-II, Springer.
4. C R Mason Art & Science of Protective Relaying, Willey.
5. Kimbark, Power System Stability Vol-II, Willey.
5. C. Christopoulos and A. Wright, Electrical Power System Protection, Springer
6. Bhavesh Bhalaja, R. P Maheshwari, Nilesh G. Chothani, Protection & Switchgear, Oxford publisher

PES-103C/24 MATHEMATICAL METHODS FOR POWER ENGINEERING

Internal Marks: 40
External Marks: 60
Total Marks: 100

L	T	P
3	0	0

Course Objectives:- Students will be able to:

CO1: Knowledge about vector spaces, linear transformation, eigenvalues and eigenvectors of Linear operators

CO2: Learn about linear programming problems and understanding the simplex method for solving linear programming problems in various fields of science and technology

CO3: Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems

CO4: Understanding the concept of random variables, functions of random variable and their probability distribution, stochastic processes and their classification.

Syllabus

Units	Content	Hours
1	Vector spaces, Linear transformations, Matrix representation of linear transformation, Eigen values and Eigen vectors of linear operator	10
2	Linear Programming Problems, Simplex Method, Duality, Non-Linear programming problems	8
3	Unconstrained Problems, Search methods, Constrained Problems	8
4	Lagrange method, Kuhn-Tucker conditions, Random Variables Distributions	8
5	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

PES-103D/24 **ANALYSIS OF POWER CONVERTER** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: Develop a systematic approach AC-DC converters
CO2: Develop a systematic approach for modeling and analysis PWM Inverters
CO3: Ability to model of Multilevel Inverters
CO4: Analysis of boost power factor corrected rectifier.

Syllabus

Units	Content	Hours
1	Overview of Switching Devices: Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices. AC-DC converters: Single phase fully controlled converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters.	12
2	Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter	10
3	PWM Inverters: Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 600PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques- Three phase current source inverters-Variable dc link inverter.	10
4	Multi level inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters-Comparisons of Multilevel Converters.	10

Suggested reading:

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003 Daniel W. Hart - McGraw-Hill,2011.
2. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
3. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.

PES-104A/24 RURAL ENERGY SYSTEMS AND SUSTAINABLE DEVELOPMENT

Internal Marks: 40
External Marks: 60
Total Marks: 100

L	T	P
3	0	0

Course Objectives:- Students will be able to:

CO1: Understand the concept of load profile in rural areas.
CO2: Interpret the environmental impacts of traditional rural energy practises.
CO3: Understand the government schemes such as NPBD, NPIC, VESP, RGGVY etc.
CO4: Interpret appropriate renewable technology for sustainable development and formulate Integrated Rural Energy Planning (IREP).

Syllabus

Units	Content	Hours
1	Traditional and modern energy use; Methods of accounting the role of traditional energy in the overall energy system. Energy consumption patterns in rural areas. Trends of rural energy consumption. Need and development of rural energy data bases (REDB); methodologies for building REDB. Case studies of REDB	10
2	Integrated Rural Energy Planning (IREP): Origin, implementation, case studies, critique. Socioeconomic and environmental issues of traditional energy use. Health impacts of biomass burning in cookstoves. The debate of black carbon from biomass burning. The energy ladder for cooking. Gender issues in biomass collection and processing.	10
3	Rural electrification: Overview, current status and future perspectives. Linkages with rural livelihoods, rural industries and social development. Issues of subsidization, last mile access and paying capacity. Use of efficient/appropriate/renewable energy technologies for rural areas. Technologies/products for cooking, water heating, drying, irrigation pumping, small/micro enterprises, lighting, motive power etc.	12
4	Review and critique of various programs of government: National Program for Biogas Development (NPBD), National Program for Improved Cookstoves (NPIC), Village Energy Security Plan (VESP), Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) etc	10

Suggested reading:

1. Report by a Panel of Experts, Rural electrification in Asia and the Far East New York United Nations, 1963.
2. B. Kaye and William S: Pintz, Rural electrification issue papersHonolulu: Pacific Islands Development. 2004
3. Chambers, Ann, Distributed Generation: A Non-technical guide, 4th Ed., Penn well, Oklahoma, 2001
4. Devadas, Planning for Rural Energy System: Part I & II, V Renewable and Sustainable Energy Reviews, 5 (2001), 203-226, 227-270.
5. T.C. Kandpal, H. P. Garg, Financial Evaluation of Renewable Energy Technology, Macmilan, New Delhi, 2003.

PES-104B/24 **WASTE TO ENERGY CONVERSION TECHNOLOGIES**

Internal Marks: 40
External Marks: 60
Total Marks: 100

L	T	P
3	0	0

Course Objectives:- Students will be able to:

CO1: Understand the issues related with waste and its impact on environment.
CO2: Knowledge of different type of disposal mechanism for handling different type of waste.
CO3: Understand the analyse concept of recovery from industrial and agricultural waste
CO4: Knowledge of rural issues and the handling of biomass.

Syllabus

Units	Content	Hours
1	Solid Waste -Definitions: Sources, types, compositions; Properties of Solid Waste; Municipal Solid Waste. Physical, chemical and biological property. Collection, transfer stations; Waste minimization and recycling of municipal waste Landfill method of solid waste disposal: Landfill classification; Types, methods & siting consideration; Layout & preliminary design of landfills: Composition, characteristics, generation; Design of Sanitary Land fill - Movement and control of landfill leachate &gases; Environmental monitoring system for landfill gases - Gas Recovery – Applications.	10
2	Waste treatment & Disposal Size Reduction: incineration; Furnace type & design; Types of Incinerators – Fuel Economy - Medical /Pharmaceutical waste / Hazardous waste / Nuclear Waste incineration, environmental impacts; Measures of mitigate environmental effects due to incineration	8
3	Energy Generation From Waste Types: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production Aerobic & Anaerobic treatments, Types of digester, Factors affecting bio-digestion Activated sludge process. Methods of treatment and recovery from the in industrial waste water – Case Studies in sugar, dairy, fertilizer, tanning, textile, and power plant.	8
4	Rural applications of biomass –Combustion, Chulas and improved Chulas. Physical and Chemical composition of biomass, properties of biomass, TGA and DSC characterization – Ash Characterization - Preparation of biomass , Size reduction – Briquetting of loose biomass- Briequtting machine	6

Suggested reading:

1. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
2. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000
3. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987
5. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC, New Delhi,1983.

PES-104C/24 SMALL HYDRO AND NON-CONVENTIONAL TECHNOLOGIES

Internal Marks: 40
External Marks: 60
Total Marks: 100

L	T	P
3	0	0

Course Objectives:- Students will be able to:

CO1: understand and learn the operation of various types of hydro systems
CO2: analyse the working of ocean thermal energy conversion systems
CO3: analyse the operation of hybrid energy systems
CO4: compare the scope of various available energy systems in India

Syllabus

Units	Content	Hours
1	Small-hydro systems: Overview of micro, mini and small hydro systems; Hydrology: Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works. Protection control and management. Advantages and Limitations, Hybrid systems, Potential of small hydro power in India.	8
2	Energy from Oceans: Ocean Thermal Electric Conversion (OTEC) methods, Open and closed cycle of OTEC, Evaporators, site selection for OTEC and hybrid cycle, Advantages and disadvantages, Prospects of OTEC in India. Tidal Energy (TE) basic principal, Operation methods, estimation of energy and power in single and double system, Advantages and disadvantages, Prospects of TE in India. Energy and power from Ocean waves, Wave energy conversion devices, Advantages and disadvantages	10
3	Geothermal Energy: Nature, hydro thermal resources, Geo pressure resources, Hot dry resources, magma resource, Flashed heat and total flow concept, Hybrid systems, Prime movers for geo-thermal energy, Advantages and disadvantages, Enviornmental issues, Potential in India.	8
4	Magneto Hydro Dynamic (MHD) Power: Principal of MHD, MHD systems, Design issues and development, Electric condition, Gas conductivity, Materials for MHD generation, Super-conductivity, International status.	8

Suggested reading:

1. Tong Jiandong(et al.) , Mini Hydropower , John Wiley, 1997
2. Rai, G.D., Non-Conventional Energy Sources, Kh Publishers, New Delhi.
3. Mathur A.N. & Rathore N.S. Renewable Energy Sources, Bohra Ganesh Publications, Udaipur, 1992
4. Kothari, Renewable Energy Sources and Emerging Technologies, PHI, Eastern Economy Edition, 2012.
5. Bansal N. K., Kleeman M. K., Mells M. Renewable Sources of Energy and Conversion Technology, Tata McGraw-Hill, 1990.

PES-104D/24 **SOLAR ENERGY CONVERSION TECHNOLOGIES**

Internal Marks: 40
External Marks: 60
Total Marks: 100

L	T	P
3	0	0

Course Objectives:- Students will be able to:
CO1: Evaluate the solar thermal devices
CO2: Optimize the solar thermal power generating system.
CO3: Knowledge of solar passive concepts and their application to buildings
CO4: Understanding of government schemes & policies on solar energy.

Syllabus

Units	Content	Hours
1	Solar Energy collectors: Physical principals. Flat plate Collector, Transmissitivity of cover system, Energy balance equations, Collector efficiency, Flat plate Collector thermal efficiency and Thermal analysis, Heat capacity effect Concentrating Collectors, Performance analysis of cylindrical parabolic concentrating collectors, selective surfaces, coating, Anti-reflective coating Measurement & estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data and applications. Solar energy storage systems, solar pond principal of operation, extraction of thermal energy from solar pond.	10
2	Solar Passive Buildings: Thermal comfort, criterion and parameters, Calculation of solar radiation on buildings, building orientation, Introduction to design of shading devices, Overhangs, Factors that effects energy use in buildings; Ventilation and its significance; Air-conditioning systems. Passive heating concepts:- Direct heat gain, indirect heat gain, isolated gain and sunspaces. Passive cooling concepts:- Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air-tunnel.	8
3	Dark and illumination characteristics; Figure of merits of solar cell; Efficiency limits, Variation of efficiency with band-gap and temperature; Efficiency measurements; High efficiency cells, Tandem structure. SPV applications - Centralized and decentralized SPV systems; Stand alone, hybrid and, grid connected system, System installation, operation and maintenances; Field experience; PV market analysis and economics of SPV systems – Government Schemes and Polices	8
4	Application of Solar Energy: Heating, cooling, thermal electric conversion, agricultural and Industrial process heat, distillation, pumping, Furnance, Cooking, production of hydrogen, Solar green houses, Thermal drying.	8

Suggested reading:

1. H. P Garg, J. Prakash, Solar Energy: Fundamentals & Applications, Tata McGraw Hill, New Delhi, 1997
2. S P Sukhatme, Solar Energy, Tata McGraw Hill, 2008
3. J. F. Kreider and Frank Kreith, Solar Energy Handbook, McGraw Hill, 2000
4. D. Y. Goswami, Frank Kreith and J F Kreider, Principles of Solar Engineering, Taylor & Francis, 1998

5. G. N. Tiwari, S. Suneja, Solar Thermal Engineering System, Narosa Publishing House, New Delhi, 1997.
6. Alan L. Fahrenbruch and Richard H Bube , Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, New York , 1983
7. Larry D Partain (ed.), Solar Cells and their Applications, John Wiley and Sons, Inc. New York, 1995
8. Richard H Bube, Photovoltaic Materials, ImperialCollege Press, 1998
9. H S Rauschenbach, Solar Cell Array Design Handbook, Van Nostrand Reinfold Company, New York, 1980.

MTRM-101-18 **RESEARCH METHODOLOGY AND IPR** L T P
Internal Marks: 40 2 0 0
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
1. To understand research problem formulation and research ethics
2. To understand about control of information technology
3. To understand the need of IPR & its protection

Syllabus

Units	Content	Hours
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	8
2	Effective literature studies approaches, analysis Plagiarism, Researchethics,	4
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	6
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	8
5	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications	4
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.	6

References:

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

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

CO1: Understand research problem formulation. Analyze research related information
CO2: Follow research ethics
CO3: Understand that today's world is controlled by Computer, Information

Technology, buttomorrow world will be ruled by ideas, concept, and creativity.

CO4: 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.

CO5: 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.

PES-105/24
Internal Marks: 60
External Marks: 40
Total Marks: 100

POWER SYSTEM ANALYSIS LAB

L	T	P
0	0	4

Course Outcomes::-Students will be able :
CO1: To understand the formation of Y-bus and Z-bus
CO2: To understand how to analyze the power system load flow studies, Faults occurring in power system
CO3: To understand the security analysis
CO4: To understand the commercial software used by industry

Syllabus

Sr. No.	List of Experiments
1	Write a program to form Y-bus by Inspection method.
2	Write a program for formation of Y-bus by singular matrix transformation
3	Study of load flow methods a) Gauss-Siedel method b) Newton Raphson Method
4	Write a program for fault analysis for a) LG b) LLG c) LLL unbalanced faults
5	Write a program for security analysis using load flow & ranking of contingency
6	Write a program for ranking of contingency using overload security analysis
7	Study of ready-made industry standard / commercial software packages for above analysis
8	Write a program to form Z-bus matrix.
9	To simulate the transient analysis of a synchronous machine under unbalanced load and fault conditions
10	To study the harmonic analysis using simulation for any electric power system
11	To develop a simulink model for a synchronous machine under steady-state analysis

Note: A student to perform any 8 experiments

PES-106/24
Internal Marks: 60
External Marks: 40
Total Marks: 100

POWER SYSTEM LAB-I

L	T	P
0	0	4

Course Outcomes:-Students will be able :
CO1: Various power curves considering different renewable sources
CO2: Evaluate the capability of fuel cells and capacitors
CO3: Understand practical issues related to wind power
CO4: Analyze the effect of variations of parameters on solar panels

Syllabus

Sr. No.	List of Experiments
1	To study the power curves
2	To build a wind farm
3	Test the capabilities of the hydrogen fuel cells and capacitors
4	To study and analyze the effect of temperature on solar panel output
5	To study the variables affecting solar panel output
6	To study the effect of load on solar panel output
7	To study the effect of load on any wind turbine output
8	To test the capabilities of solar panels and wind turbines
9	To study the impact of integrating renewable energy system on any conventional energy source
10	To study the HVDC transmission line using simulation
11	To simulate a medium and long length transmission line and compare the voltage regulations
12	To study the power factor improvement of any electric power system connected to an inductive load

Note: A student to perform any 8 experiments

Audit-1 Courses for 1st Semester

Type of Course	Course Code	Course Name
Audit-1	MTA-101/18	English for Research Paper Writing
	MTA-102/18	Disaster Management
	MTA-103//18	Sanskrit for Technical Knowledge
	MTA-104/18	Value Education

MTA-101/18 **ENGLISH FOR RESEARCH PAPER WRITING** L T P
Internal Marks: 00 2 0 0
External Marks: 00
Total Marks: 00

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

Syllabus

Units	Content	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 first time submission	4

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

Course Outcome:- Students will be able to learn

CO1: Improve writing and readability levels for English
CO2: How to write and what write according to section
CO3: Skills in title writing

MTA-102/18 **DISASTER MANAGEMENT**

L	T	P
2	0	0

Internal Marks: 00
External Marks: 00
Total Marks: 00

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 practicefrom multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance inspecific 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 thecountries they work in

Syllabus

Units	Content	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, Lossof Human And Animal Life, Destruction Of Ecosystem. NaturalDisasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-madedisaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil SlicksAnd Spills, Outbreaks Of Disease And Epidemics, War AndConflicts	4
3	Disaster Prone Areas In India, Study Of Seismic Zones; Areas ProneTo 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: MonitoringOf Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From MeteorologicalAnd Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	Risk Assessment , Disaster Risk: Concept And Elements, DisasterRisk Reduction, Global And National Disaster Risk Situation.Techniques Of Risk Assessment, Global Co- Operation In RiskAssessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4

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

Course Outcome:- Student will be able

CO1: Know, how to reduce disaster risk and humanitarian response.
CO2: Policy and practice for disaster risk reduction
CO3: Understand the practical relevance of conflict situations and standards of humanitarianresponse in that situation
CO4: Planning, programming and strength and weakness of disaster risk management.

MTA-103/18 **SANSKRIT FOR TECHNICAL KNOWLEDGE** L T P
2 0 0

Internal Marks: 00
External Marks: 00
Total Marks: 00

Course Objectives:-Students will be able to:

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 & othersubjects enhancing the memory power.
4. The engineering scholars equipped with Sanskrit will be able toexplore the huge knowledge from ancient literature

Syllabus

Units	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 readings:

1. "Abhyaspustakam" – Dr.Vishwas, Sanskrit-Bharti Publication,New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya SanskritSansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi

Course Outcome:-Students will be able to

CO1: Understanding basic Sanskrit language
CO2: Ancient Sanskrit literature about science & technology can be understood
CO3: Being a logical language will help to develop logic in students.

MTA-104/18 VALUE EDUCATION

L	T	P
2	0	0

Internal Marks: 00
External Marks: 00
Total Marks: 00

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

Units	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, Lovefor nature, Discipline	6
3	Personality and Behavior 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-destructivehabits, 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,Nonviolence, 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

CO1: Knowledge of self-development
CO2: Learn the importance of Human values
CO3: Developing the overall personality

Copy

Name

23	Board of Studies for PG studies in Electrical Engineering, Electrical and Electronics Engineering, Electronics and Electrical Engineering 28th May, 2024 IK Gujral Punjab Technical University Main Campus

PES-201/24 **RENEWABLE DISTRIBUTION SYSTEMS** **L T P**
Internal Marks: 40 **4 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: Interpret the economics of renewable energy systems
CO2: Conceptualize and design photovoltaic system
CO3: Knowledge about different types of solar conversion technology and its grid interface
CO4: Knowledge about different types of wind energy conversion technology and its grid interface

Syllabus

Units	Content	Hours
1	Photovoltaic (PV) cell characteristics and equivalent circuits, model of PV cell, various parameters of PV cell and its datasheet study, effect of temperature on PV cell, fill factor, series and parallel connection of PV cell, interconnection of non-identical PV modules in series and parallel, Introduction to solar irradiance and insolation, solar geometry, incident solar energy estimation on flat plate and tilted flat plat collector, solar insolation with atmospheric effects, airmass, clearness index	12
2	Sizing of PV system without battery, battery introduction and various battery parameters, battery selection, load calculation, days of autonomy and recharge, PV system design with battery, PV array design and selection, Maximum Power Point Tracking (MPPT) technique, MPPT algorithms, input impedance model of power converters for MPPT, direct PV and battery connection, charge controller, battery charger design	12
3	Grid connection principle, PV and wind to grid topologies, three phase *d-q* controlled grid connection ac to dc and dc to ac transformations, three phase grid-controlled connection, single phase grid-controlled connection, space vector pulse width modulation technique.	10
4	Wind in the world, wind energy scenario in India, speed and power relations, power extracted from wind, wind speed distribution, Weibull probability distribution, wind system components – tower, turbine blades, yaw control and speed control. Grid connected and self-excited induction generator operation, constant voltage and constant frequency generation, variable voltage and variable frequency generation. Working principle and its operation: Double fed induction generator, and permanent magnet synchronous generator.	12
5	Distributed generation overview, radial distribution system protection, distribution system loading, line drop model, loop and secondary network distribution, impact of distributed generation, relaying and protection, intentional and unintentional islanding, various issues in power converter design, costing and life cycle, low voltage ride through capability	10

Suggested Reading:

1. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall India.
2. S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Publications.
3. S. M. Muyeen, Wind Energy Conversion Systems: Technology and Trends, Springer.
4. S. P. Sukhatme, J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Mcgraw Hill, India
5. Joshua Earnest, Wind Power Technology, Prentice Hall, India.
6. Math H. Bollen, F. Hassan, Integration of Distributed Generation in Power System, Wiley- IEEE press.

	Saving in Compressors & Compressed Air Systems Cooling towers, its types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers. Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractory, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.)Study of Energy Audit reports for various Industries and Organization	

Suggested Reading:

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
4. Energy Management Principles, C.B.Smith, Pergamon Press
5. Industrial Energy Conservation, D.A. Reay, Pergammon Press
6. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
7. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988
8. Hand Book of Energy Audits, Albert Thumann, P.E., C.E.M. William J. Younger, C.E.M., CRC Press.

PES-202/24 | **POWER SYSTEM DYNAMICS** | **L T P**
Internal Marks: 40 | **4 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: Understand the modeling of synchronous machine in details
CO2: Development of mathematical models for synchronous machine
CO3: Analysis and physical interpretation of models of Synchronous machine
CO4: Modeling of induction motor and understand the load modeling in power system.

Syllabus

Units	Content	Hours
1	Synchronous Machines: Per unit systems; Park's Transformation (modified), Flux-linkage equations.	12
2	Voltage and current equations; Formulation of state-space equations, Equivalent circuit.	10
3	Sub-transient and transient inductance and Time constants, Simplified models of synchronous machines	10
4	Small signal model: Introduction to frequency model. Excitation systems and Philips-Heffron model; PSS Load modeling.	12
5	Modeling of Induction Motors, Prime mover controllers.	8

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

Professional Electives for 2nd Semester

Professional Elective	Course Code	Course Name
PE3	PES-203A/24	Energy Conservation and Audit
	PES-203B/24	Advanced Power Systems Protection
	PES-203C/24	Reliability Analysis and Protection
	PES-203D/24	Energy Economics and Policies
PE4	PES-204A/24	Electric and Hybrid Vehicles
	PES-204B/24	Smart Grids
	PES-204C/24	Engineering Optimization
	PES-204D/24	Artificial Intelligence Techniques

PES-203A/24 **ENERGY CONSERVATION AND AUDIT** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:-Students will be able to:
CO1: Describe and formulate basic-auditing terms and analyze the auditing approaches for a selective industry.
CO2: Evaluate the performance analysis and optimization of thermal utilities.
CO3: Formulate energy action planning for various types of industry.
CO4: Describe and categorize the global environmental concerns for effective energy

Syllabus

Units	Content	Hours
1	Energy Audit Methodology and recent trends. General Philosophy, need of Energy Audit and Management, EC Act, Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy. Economics of implementation of energy optimization projects, it's constraints, barriers and limitations, Financial Analysis: Simple Payback, IRR, NPV, Discounted Cashflow; Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS, Case-studies/Report studies of Energy Audits. Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy. Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities	6
2	Electrical Distribution and Utilization: Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side Management (DSM), Load Management, Harmonics & its improvements, 11 25-30% Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches. Study of 4 to 6 cases of Electrical Energy audit and management (Power factor improvement, Electric motors, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, etc.)	8
3	Thermal Systems: Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- it's limitations and constraints. Furnaces- Types and classifications, applications, economics and quality aspects, heat distributions, draft controls, waste heat recovering options, Furnaces refractory- types and sections. Thermic Fluid heaters, need and applications, Heat recovery and its limitations. Insulators-Hot and Cold applications, Economic thickness of insulation, Heat saving and application criteria. Steam Utilization Properties, steam distribution and losses, steam trapping, Condensate, Flash steam recovery.	8
4	System Audit of Mechanical Utilities: Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems. Bloomers (Blowers) types & application, its performance assessment, series & parallel operation applications & advantages.	8
5	Energy Saving in Blowers Compressors, types & applications, specific power consumption, compressed air system, & economic of system changes. Energy	8

PES-203B/24 **ADVANCED POWER SYSTEMS PROTECTION** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: Learn about classification and operation of static relays.
CO2: Understand the basic principles and application of comparators.
CO3: Understand static version of different types of relays.
CO4: Understand about numerical protection techniques.

Syllabus

Units	Content	Hours
1	Static Relays classification and Tools: Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators, Duality, Basic Tools, Schmitt Trigger Circuit, Multivibrators, Square wave Generation, Polarity detector, Zero-crossing detector, Thyristor and UJT Triggering Circuits. Phase sequence Filters, Speed and reliability of static relays.	8
2	Amplitude and Phase Comparators (two Input): Generalized equations for Amplitude and Phase comparison, Derivation of different characteristics of relays, Rectifier Bridge circulating and opposed voltage type amplitude comparators, Averaging & phase splitting type amplitude comparators: Principle of sampling comparators. Phase Comparison: Block Spike and phase Splitting Techniques, Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison, Vector product devices.	10
3	Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi-input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings,	8
4	PILOT Relaying schemes: Wire pilot protection, circulating current scheme, balanced voltage scheme, translay scheme, half wave comparison scheme, carrier current protection: phase comparison type, carrier aided distance protection, operational comparison of transfer trip and blocking schemes, optical fibre channels.	8
5	Microprocessor based relays and Numerical Protection: Introduction, over current relays, impedance relay, directional relay, reactance relay. Numerical Protection: Introduction, numerical relay, numerical relaying algorithms, Mammorrison technique, Differential equation technique and discrete Fourier transform technique, numerical over current protection and numerical distance protection.	8

Suggested Reading:

1. T.S.M. Rao, Power System Protection with Static Relays, TMH.
2. Badri Ram & D. N. viswakarma, Power system protection & switchgear, TMH.
3. Warrington Protective Relaying Vol-II, Springer.
4. C R Mason Art & Science of Protective Relaying, Willey.
5. Kimbark, Power System Stability Vol-II, Willey.
6. C. Christopoulos and A. Wright, Electrical Power System Protection, Springer
7. Bhavesh Bhalaja, R. P Maheshwari, Nilesh G. Chothani, Protection & Switchgear, Oxford publisher

PES-203C/24 **RELIABILITY ANALAYSIS AND PROTECTION** **L T P**
3 0 0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: Have knowledge of different methods to estimate different electrical quantities
CO2: Acquire skills in planning and building reliable power system.
CO3: Manage skills required in the field of power system engineering are enhanced.
CO4: Understand about modes of failure and calculate relevant indices.

Syllabus

Units	Content	Hours
1	Long and short term planning. Load forecasting, characteristics of loads. Methodology of forecasting, energy forecasting. Peak demand forecasting, total forecasting. Annual and monthly peak demand forecasting.	6
2	Reliability concepts, exponential distributions. Meantime to failure, series and parallel system, MARKOV process. Recursive technique. Generator system reliability analysis. Probability models for generators unit and loads. Reliability analysis of isolated and interconnected system, generator system cost analysis, corporate model. Energy transfer and off peak loading.	12
3	Transmission system reliability model analysis: Monte Carlo simulation. Average interruption rate. LOLP method, frequency and duration method.	7
4	Two plant single load system. Two plant two load system. Load forecasting uncertainly interconnections benefits.	7
5	Introduction to system modes of failure. The loss of load approach. Frequency& duration approach. Spare value assessment. Multiple bridge equivalents. Distribution system reliability analysis. Calculation of indices SAIFI, SAIDI, CAIDI, etc.	10

Suggested Reading:

1. Sullivan, R.L., "Power System Planning", Heber Hill.
2. Roy Billington, "Power System Reliability Evaluation", Gordan& Breach Scain Publishers.

PES-203D/24 **ENERGY ECONOMICS AND POLICIES** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: understand the importance of energy in economic development.
CO2: Understand the need of sustainable energy.
CO3: Understand the issues related to energy pricing taxes
CO4: Take up research in energy economics.

Syllabus

Units	Content	Hours
1	Introduction: Natural Resources, Classification, Importance, Role of Natural Resources in Economic Development, Energy Resources – Classification, Properties and forms of Energy , Energy Economics – origin, Scope and Nature. Energy and development: Role of Energy in Economic Development, Energy Indicators, Energy Intensity and Energy Elasticity – National and International Comparison – Role of International Institutions-OPEC, OAPEC, IEA, and World Bank.	10
2	Energy and environment: Energy Environment Nexus Crisis – Causes and Consequences – Remedial Measures –Impact of Energy Consumption and Production on Environment with illustrations – Role of Energy Economists in solving Energy Crises.	8
3	Planning and Development: Energy Planning and Energy Conservation – Meaning, Objectives and Importance.	8
4	Energy Management: Meaning, Objectives and Importance – Recent Developments, Energy Auditing, Energy Accounting, Energy conservation, Energy Pricing and Taxes – Role of Economists in Sustainable Energy Management.	8
5	Indian Energy Sector: Organizational Structure, Energy Supply sources and trends in production, Energy Demand on sectoral consumption trend, Renewable Energy Sources and Technologies Renewable Energy Programmes in India	8

Suggested Reading:

1. Agarwal, M.C. and Monga, J.R. (1992): Economic and Commercial Geography,National Publishing House, New Delhi.
2. Agarwal, S.K. (1985): Environment and Natural Resources Economics, Scott Foresman & Co., London.
3. Common, M. (1985): Environmental and Resource Economics, Longman, London.
4. David Pearct et al., (1990): Sustainable Development – Economics and Environment in the Third World, Earths Can Publications, London.
5. Karpagam, M. (1991): Environmental Economics, Sterling, New Delhi.
6. Kneese. A.V and Sweeny, J.L, 1993): Handbook of Natural Resource and Energy Economics, North Holland.
7. Munasinghe, M and Meier, P (1993): Energy Policy and Modeling, Cambridge, University Press, UK.
8. Richard Eden (1981): Energy Economics – Growth, Resources and Policies, Cambridge University Press, London.

PES-204A/24 **ELECTRIC AND HYBRID VEHICLES** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:-Students will be able to:
CO1: Know the concept of electric vehicles and hybrid electric vehicles.
CO2: Familiar with different motors used for hybrid electric vehicles.
CO3: Understand the power converters used in hybrid electric vehicles
CO4: Know different batteries and other energy storage systems.

Syllabus

Units	Content	Hours
1	Introduction: History of hybrid vehicles, architectures of HEVs, series and parallel HEVs, complex HEVs.	6
2	Hybridization of Automobile: Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.	8
3	Plug-in Hybrid Electric Vehicle: PHEVs and EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, PHEV battery charging.	8
4	Power Electronics in HEVs: Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, isolated bidirectional DCDC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.	8
5	Battery and Storage Systems Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource	8

Suggested Reading:

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
5. H. Partab: Modern Electric Traction - DhanpatRai& Co, 2007.
6. Pistooa G., "Power Sources , Models, Sustanability, Infrstructure and the market", Elsevier 2008
7. Mi Chris, Masrur A., and Gao D.W., " Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives" 1995.

PES-204B/24 | **SMART GRIDS** | **L T P**
Internal Marks: 40 | **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:-Students will be able to:
CO1: Understand concept of smart grid and developments on smart grid.
CO2: Understand smart grid technologies and application of smart grid concept in hybrid electric vehicles.
CO3: Have knowledge on smart substations, feeder automation and
CO4: Knowledge of monitoring and protection of grid.

Syllabus

Units	Content	Hours
1	Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.	6
2	Smart Grid Technologies: (Part 1): Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.	8
3	Smart Grid Technologies: (Part 2): Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).	8
4	Micro grids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources.	8
5	Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN).	8

Suggested Reading:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.
4. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
5. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010.
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Micro-grids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009.
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press

PES-204C/24 **ENGINEERING OPTIMIZATION** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives: Students will be able to:
CO1: Understand the need for optimization and different techniques involved and also constraints.
CO2: Knowledge of Linear/Non-linear Programming.
CO3: Understand the importance of optimization to solve Engineering problems
CO4: Knowledge of genetic algorithm for Engineering Optimization

Syllabus

Units	Contents	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 prob ems.	8
4	Nonlinear programming: Non linearity concepts-convex and concave functions non-linear programming-gradient and Hessian. Unconstrained optimization First & Second order necessary conditions- Minimization & Maximization 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-Lagrange 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 packages	6

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.

PES-204D/24 **ARTIFICIAL INTELLIGENCE TECHNIQUES** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives: Students will be able to:
CO1: Learn the concepts of biological foundations of artificial neural networks
CO2: Learn Feedback networks and radial basis function networks and fuzzy logics
CO3: Identifications of fuzzy and neural network
CO4: Acquire the knowledge of GA

Syllabus

Units	Contents	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: Genetic algorithm: Reproduction cross over, mutation, Introduction to evolutionary program	8
5	Applications of above mentioned techniques to practical problems	10

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.

PES-205/24
Internal Marks: 60
External Marks: 40
Total Marks: 100

MINI PROJECT

L	T	P
0	0	4

Course Objectives:-Students will be able :
CO1: To develop a small prototype model/simulation in power and energy system
CO2: To focus more on emerging technologies of energy systems and understand their power quality aspects
CO3: To verify and analyze the outcome of the developed system.

Students need to develop a small working system in prototype or using any Simulink software or any computer programing language. Student can use any of the following software for carrying out the simulation work: Matlab, LabVIEW, PSCAD, ETAP etc. Student need to link this research work using various literature surveys with Phase-1 Dissertation and Phase-2 Dissertation work.

PES-206/24
Internal Marks: 100
External Marks: 00
Total Marks: 100

SEMINAR

L	T	P
0	0	2

Course Objectives:-Students will be able : **CO1:** analyze the emerging developments taking place in power and energy systems **CO2:** analyze and find the major gaps of the work done. **CO3:** to develop the objectives required for dissertation works in next semesters
Students will prepare a power point presentation for the literature survey studies for the chosen area. Then, the student needs to find the major gaps from the survey studies. Accordingly, student will develop the major objectives and conclude the major findings of the proposed system. It is imperative to link the seminar with Phase-1 Dissertation and Phase-2 Dissertation work.

PES-207/24
Internal Marks: 60
External Marks: 40
Total Marks: 100

POWER SYSTEM LAB-2

L	T	P
0	0	4

Course Objectives:-Students will be able :
CO1: To understand power curves for energy sources
CO2: Effect of variable parameters on solar panels
CO3: Relation of wind output and load.

Syllabus

Sr. No.	List of Experiments
1.	To simulate a solar PV grid connected system coordinated with any DVR
2.	To simulate a solar PV grid connected system coordinated with any D-STATCOM
3.	To simulate a hybrid energy system operated with any type of FACTS device and analyze its power quality.
4.	To study various power quality issues in renewable based energy system using IEEE 1547 standard
5.	To study the DC-DC converter system with any renewable based energy system
6.	To study the DC-AC converter system with any renewable based energy system
7.	To study the impact of any fault load side for any renewable based energy system
8.	To study the frequency and voltage stability for an electric power system
9.	Single phase parallel inverter with *R* and *RL* loads.
10.	Single phase bridge converter with *R* and *RL* loads
11.	Single phase dual converter with *RL* loads

Note: A student to perform any 8 experiments

PES-208/24
Internal Marks: 60
External Marks: 40
Total Marks: 100

RENEWABLE ENERGY LAB

L	T	P
0	0	4

Course Objectives: Students will be able to:
CO1: Assess the performance of renewable sources of energy
CO2: Knowledge of the scope of tapping geothermal energy
CO3: Field visit to assess the solar lighting
CO4: Knowledge of the practical aspects of integration of renewable sources of energy to the grid

Syllabus

Sr. No.	List of Experiments
1.	To determine the efficiency of solar Photovoltaic (PV) grid-tied system.
2.	To determine the efficiency of wind energy system.
3.	Field visit to solar street lighting system.
4.	To determine the power output of a biogas plant
5.	To study a geothermal system
6.	To determine the efficiency of a PEM fuel cell
7.	To determine the efficiency of a mini hydro plant
8.	To study the power quality issues during grid integration of multiple renewable energy sources
9.	To study the impact of any maximum power point tracking technique on power quality for a solar PV system
10.	To study the operation of DC-DC/DC-AC converter systems in any renewable energy system
11.	To study the operation of any intelligent controller for hybrid energy systems
12.	To simulate a wind energy generator and analyze the output
13.	To study and compare the efficiency of various types of solar PV cells

Note: A student to perform any 8 experiments

Audit-2 courses for 2nd Semester

Type of Course	Course Code	Course Name
Audit-2	MTA-105/18	Constitution of India
	MTA-106/18	Pedagogy Studies
	MTA-107/18	Stress Management by Yoga
	MTA-108/18	Personality Development through Life Enlightenment Skills

MTA-105/18 **CONSTITUTION OF INDIA** **L T P**
Internal Marks: 00 **2 0 0**
External Marks: 00
Total Marks: 00

Course Objectives: Students will be able to

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

Syllabus

Units	Content	Hours
1	History of Making of the Indian Constitution: History, DraftingCommittee, (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 StatePolicy, Fundamental Duties.	4
4	Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions	4
5	Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role ofElected 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 andFunctioning, 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

Suggest 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:

CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2: Discuss the intellectual origins of the framework of argument that informed theconceptualization of social reforms leading to revolution in India.

CO3: 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.

CO4: Discuss the passage of the Hindu Code Bill of 1956.

MTA-106/18 **PEDAGOGY STUDIES**

L	T	P
2	0	0

Internal Marks: 00
External Marks: 00
Total Marks: 00

Course Objectives: Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policymaking undertaken by the DfID, other agencies and researchers.
2. 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:

CO1: What pedagogical practices are being used by teachers in formal and informalclassrooms in developing countries?

CO2: What is the evidence on the effectiveness of these pedagogical practices, in whatconditions, and with what population of learners?

CO3: How can teacher education (curriculum and practicum) and the school curriculum andguidance materials best support effective pedagogy?

MTA-107/18 | **STRESS MANAGEMENT BY YOGA** | **L T P**
Internal Marks: 00 | **2 0 0**
External Marks: 00
Total Marks: 00

Course Objectives: Students will be able to:
1. To achieve overall health of body and mind
2. To overcome stress

Syllabus

Units	Contents	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	6
3	Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types ofpranayama	6

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:

CO1: Develop healthy mind in a healthy body thus improving social health also
CO2: Improve efficiency

MTA-108/18 **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**

Internal Marks: 00
External Marks: 00
Total Marks: 00

L	T	P
2	0	0

Course Objectives: Students will be able to:
1. To learn to achieve the highest goal happily
   a. To become a person with stable mind, pleasing personality and determination
   b. To awaken wisdom in students

Syllabus

Units	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)	10
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.	10
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

CO1: Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life

CO2: The person who has studied Geeta will lead the nation and mankind to peace and prosperity

CO3: Study of Neetishatakam will help in developing versatile personality of students.

Professional Electives for 3rd Semester

Professional Elective	Course Code	Course Name
PE5	PES-301A/24	Industrial Load Modelling and Control
	PES-301B/24	Power System Deregulation
	PES-301C/24	Solar PV Energy System
	PES-301D/24	Power System Generation Control

PES-301A/24 **INDUSTRIAL LOAD MODELING AND CONTROL**

L	T	P
3	0	0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives:- Students will be able to:
CO1: Knowledge about load control techniques in industries and its application.
CO2: Different types of industrial processes and optimize the process using tools like LINDO and LINGO.
CO3: Apply load management to reduce demand of electricity during peak time.
CO4: Apply different energy saving opportunities 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.	6
4	Cooling and heating loads- load profiling- Modeling. Cool storage-Types- Control strategies. Optimal operation-Problem formulation- Case studies. Captive power units- Operating and control strategies- Power Pooling- Operation models. Energy banking-Industrial Cogeneration	12
5	Selection of Schemes Optimal Operating Strategies. Peak load saving-Constraints-Problem formulation- Case study. Integrated Load management for Industries	8

Suggested reading:

1. C.O. Bjork "Industrial Load Management - Theory, Practice and Simulations", Elsevier, theNetherlands,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, New Delhi, 1995.
6. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective Planning in Industrial facilities", IEEE Inc, USA.

PES-301B/24 **POWER SYSTEM DEREGULATION** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives: Students will be able to:
CO1: knowledge about the restructuring and deregulation of power sector.
CO2: Introduction to the fundamental concepts relevant to OASIS, congestion management etc.
CO3: Knowledge of power market and its mitigation techniques
CO4: Understand the factors related with deregulation of power industry in different countries

Syllabus

Units	Contents	Hours
1	Introduction: Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, components of deregulated system, advantages of competitive system. Power System Restructuring: An overview of the restructured power system, Difference between integrated power system and restructured power system. Explanation with suitable practical examples	8
2	Deregulation of Power Sector: Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services.	8
3	Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services, Transmission Pricing. Open Access Same Time Information System (OASIS): Introduction, structure, functionality, implementation, posting of information, uses. Transmission Pricing: Marginal pricing of Electricity, nodal pricing, zonal pricing, embedded cost, Postage stamp method, Contract Path method, Boundary flow method, MW-mile method, MVA-mile method, Comparison of different methods.	8
4	Congestion Management: Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC), Available transfer capability (ATC), Different Experiences in deregulation: England and Wales, Norway, China, California, New Zealand and Indian power system.	6
5	Different Experiences in deregulation: U.S.A, Canada, U.K, Japan, Switzerland, Australia, Sweden, Germany and Indian power system	8

Suggested Reading:

1. Power System Restructuring and Deregulation by Loi Lei Lai, John Wiley & Sons Ltd.
2. Understanding Electric Utilities and Deregulation by Lorrin Philipson and H. Lee Willis, Marcel Dekker Inc, New York, CRC Press.
3. Power System Restructuring Engineering & Economics by Marija Ilic by Francisco Galiana and Lestor Fink, Kulwer Academic Publisher, USA.

PES-301C/24 **SOLAR PV ENERGY SYSTEM** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:
CO1: Understand the fundamental theory governing the photovoltaic devise
CO2: Ability of carry out preliminary system design.
CO3: Knowledge of testing and assessment of power generation by solar PV.
CO4: Analysis of solar data

Syllabus

Units	Contents	Hours
1	Solar Radiation: Sun as Energy Source, Solar Radiation at The Earth's Surface, Solar Radiation Geometry, Solar Time and Equation of Time, Sun Earth angles, Sun path diagram, Sunshine hours, Measurement of Solar Diffuse, Global and Direct Solar Radiation, Equipment's, Estimation of Solar radiation on horizontal and tilted Surfaces, Global Solar radiation data, Indian Solar Radiation data analysis	10
2	Solar Cells Conversion of Solar energy into Electricity - Photovoltaic (PV) Effect, Equivalent Circuit of the Solar Cell, Analysis of PV Cells: Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, High efficiency cells, Recent developments in Solar Cells, Role of nano-technology in Solar cells	10
3	Fabrication Technology for Solar Cells High efficiency multi-junction solar cell, Quantum well solar cell, Technology for the fabrication of thin film cells, Optical concentration, Effect of temperature on Cell performance, Thermo PV effect Solar PV System Design Solar cell array system analysis and performance prediction, Shadow analysis: Reliability, Solar cell array design concepts, PV system design, Design process and optimization: Detailed array design, Voltage regulation, Maximum tracking, Quick sizing method, Array protection.	12
4	Solar PV System Testing Sun Simulator, Testing and performance assessment of Solar PV generator, Electronic Control and Regulation, Power Conditioning, Converters and inverter, Concentrating system, System design and configuration	10

Suggested Reading:

1. Fundamentals of Solar Cells: PV Solar Energy Conversion by AL Fahrenbruch and RH Bube, Academic Press, New York.
2. Principles of Solar Engineering by F Kreith and JF Kreider, McGraw-Hill.
3. Solar Photovoltaic, Fundamental Technologies and Application by Chetan Singh Solanki, PHI Publications.

PES-301D/24 **POWER SYSTEM GENERATION CONTROL** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:-Students will be able to:
CO1: Understand the basic principle of load frequency control and economic load dispatch
CO2: compare and analyze the security and contingency analysis
CO3: understand the importance of voltage control with varying reactive power in the system
CO4: develop the forecasting algorithms using various mathematical models

Syllabus

Units	Content	Hours
1	Automatic Generation and Voltage Control: Introduction; Load Frequency Control (Single Area Case); Load Frequency Control and Economic Dispatch Control; Two-Area Load Frequency Control; Optimal (Two-Area) Load Frequency Control; Automatic Voltage Control; Load Frequency Control with Generation Rate Constraints (GRCs); Speed Governor Dead-Band and Its Effect on AGC; Digital LF Controllers; Decentralized Control.	6
2	Power System Security: Introduction; System State Classification; Security Analysis; Contingency Analysis	8
3	Reactive Power and Voltage Control: Introduction; Reactive power requirement of an uncompensated line; Implication of surge impedance loading; Reactive loss characteristics of transmission line; Operation of a transmission line at no load condition; Operation of a transmission line under heavy loading condition; Voltage regulation of the transmission line and its relation with reactive power; Maximum power transfer in an uncompensated line; Line loadability. Reactive power-voltage (Q-V) coupling concept; Governing effects on reactive power flow; Relation between voltage and reactive power at a node in a power system; Reactive power requirement for control of voltage in long lines; Operational aspects in reactive power and voltage control; Basic principle of system voltage control; Reactive power flow constraints and their implications in loss of voltage; Effect of transformer tap changing in the post disturbance period; Effect of generator excitation adjustment in the post disturbance period; Practical aspects of reactive power flow problems leading to voltage collapse in EHV lines.	8
4	State Estimation: Introduction; Least Squares Estimation: The Basic Solution; Static State Estimation of Power Systems; Tracking State Estimation of Power Systems; Some Computational Considerations; External System Equivalency; Treatment of Bad Data; Network Observability and Pseudo-Measurements; Application of Power System State Estimation	8
5	Load Forecasting: Introduction; Forecasting Methodology; Estimation of Average and Trend Terms; Estimation of Periodic Components; Estimation of ys(k): Time Series Approach; Long-Term Load Predictions Using Econometric Models; Reactive Load Forecasting.	8

Suggested Reading:

1. Modern Power System Analysis – D. P. Kothari, I. J. Nagrath, TMH Publication
2. An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems – A Chakrabarti, D P Kothari, A K Mukhopadhyay, Abhinandan De, PHI
3. Electrical Power Systems – P. Venkatesh, B.V. Manikandan, S.C. Raja, A. Srinivasan, PHI
4. Power System Analysis – J. J. Grainger, W.D. Stevenson, Mc-GrawHill series publication
5. Power Generation Operation and Control – A. J. Wood, B. F. Woolenberg, John Wiley and Sons
6. Power System Analysis – Hadi Saadat, Mc-GrawHill series publication
7. Advanced Power System Analysis and Dynamics – L. P. Singh, New Age Internationa

Open Electives

Course Code	Course Name
MTOE-301A/18	Business Analysis
MTOE-301B/18	Industrial Safety
MTOE-301C/18	Operations Research
MTOE-301D/18	Cost Management of Engineering Projects
MTOE-301E/18	Composite Materials
MTOE-301F/18	Waste to Energy

MTOE-301A/18 **BUSINESS ANALYSIS** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:-Students will be able to:
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.

Syllabus

Units	Content	Hours
1	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
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
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
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
5	Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	8
6	Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	4

Suggested reading

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.

Course Outcome:-

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 modelling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

MTOE-301B/18
Internal Marks: 40
External Marks: 60
Total Marks: 100

INDUSTRIAL SAFETY

L	T	P
3	0	0

Course Objectives:-Students will be able to:

1. Understand about industrial safety and maintenance engineering
2. Learn possible ways of prevention from wear and tear and methods of fault tracing
3. Understand periodic maintenance

Syllabus

Units	Content	Hours
1	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.	8
2	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.	8
3	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.	8
4	Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	8
5	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.	8

Suggested reading:

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.

Course Outcome:- Student will be able

1. To know about industrial safety and ways of prevention of wear and tear
2. Learn about fault identification and periodic maintenance.
3. To get knowledge about all safety measures

MTOE-301C/18 **OPERATIONS RESEARCH** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:-Students will be able to:
1. To learn the optimization techniques
2. How to formulate LPP and handling of Nonlinear programming
3. How to do the scheduling and sequencing of models

Syllabus

Units	Content	Hours
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.	8
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.	8
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.	8
4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	8
5	Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	8

Suggested reading

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

Course Outcomes: 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.

MTOE-301D/18 **COST MANAGEMENT OF ENGINEERING PROJECTS** **L T P**
Internal Marks: 40 **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:-Students will be able to
1. To get knowledge about cost concept and cost management process
2. To know about meaning and process of project execution
3. To learn quantitative techniques and cost planning

Syllabus

Units	Content	Hours
1	Introduction and Overview of the Strategic Cost Management Process	6
2	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.	6
3	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.	10
4	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.	10
5	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	8

Suggested reading:

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. Atkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Outcomes: Student should be able to

1. Understand cost management process
2. To execute project considering cost factor
3. To manage planning of cost and learn about the techniques

MTOE-301E/18 | **COMPOSITE MATERIALS** | **L T P**
Internal Marks: 40 | **3 0 0**
External Marks: 60
Total Marks: 100

Course Objectives:-Students will be able to:
1. To understand composite materials and their reinforcement
2. Manufacturing of matrix

Syllabus

Units	Content	Hours
1	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.	8
2	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.	8
3	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.	8
4	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.	8
5	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.	8

Suggested text book reading:

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.

Suggested reference reading:

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.

Course Outcome:- Student will be able to
1. Learn about composite materials and their process of reinforcement
2. Understand about strength and manufacturing of matrix

MTOE-301F/18
Internal Marks: 40
External Marks: 60
Total Marks: 100

WASTE TO ENERGY

L	T	P
3	0	0

Course Objectives:-Students will be able to:

1. Understand classification of waste and about energy from waste
2. Process of biomass waste conversion to energy
3. To understand biomass waste properties

Syllabus

Units	Content	Hours
1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.	8
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	8
3	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.	8
4	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.	8
5	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.	8

Suggested reading:

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.

Course Outcome:- Student will be able to

1. Know about the energy in biomass waste
2. Understand the biomass fuel conversion process for energy
3. Know about biomass waste properties.