Course Structure and Syllabus
of
B.Tech Programme
In

ELECTRICAL ENGINEERING

(Admission Batch: 2018-19 Onwards)

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG
(An Autonomous Institute of Government of Odisha)
Dhenkanal, Odisha- 759146
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INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

Course Structure for 4th Year B.Tech ELECTRICAL ENGINEERING
(Admission Batch: 2018-19 Onwards)

Seventh Semester

Theory

Course Code	Course Name	L-T-P (Periods/ Week)	Credits
	Programme Core Subject		
PCEE4411	Utilization of Electrical Energy	3-0-0	3
PCEE4412	High Voltage Engineering	3-0-0	3
(Any One)	***Programme Elective III***	3-0-0	3
PEEE5406/	HVDC Transmission Systems		
PEEE5407	Restructured Power Systems		
(Any One)	***Programme Elective IV***	3-0-0	3
PEEE5408/	Switch Gear & Protective Devices		
PEEE5409	Advanced Control System		
PEEE5415	Renewable Energy Systems		
(Any One)	**Open Elective IV** Refer List of Open Electives	3-0-0	3
	Total (Theory)	**15**	**15**
	Honours/ Minor	3-1-0	4
HNEE0405/	Power Plant Engineering/		
MNEE0405	Switch Gear & Protective Devices		
	Practical/ Sessional		
PJEE8402	Minor Project	0-0-6	3
PJEE8403	Seminar and Technical Paper Writing	0-0-3	2
	Total (Practical/ Sessional)	**9**	**5**
	TOTAL	**24**	**20**
TOTAL SEMESTER CREDITS: 20			
TOTAL CUMULATIVE CREDITS: 145			

Eighth Semester

(A) *For students who carry out Major Project in the Institute*

Theory

Course Code	Course Name	L-T-P (Periods/ Week)	Credits
(Any One)	***Programme Elective V***	3-0-0	3
PEEE5410/	Energy Audit and Management		
PEEE5411	Smart Grid		
(Any One)	***Programme Elective VI***	3-0-0	3
PEEE5412/	Electrical and Hybrid Vehicles/		
PEEE5413	Advanced Electric Drives		
PEEE5414	Artificial Intelligence & Machine Learning		
	Total (Theory)	**6**	**6**
	Practical/ Sessional		
PJEE8405	Major Project	0-0-12	6
PJEE8406	Comprehensive Viva Voce	0-0-3	1
PJEE8404	Internship	0-0-3	2
	Total (Practical/ Sessional)	**18**	**9**
	TOTAL	**24**	**15**

OR

(B) *For students who carry out Internship based Major Project*

Practical/ Sessional

PJEE8407	Internship based Major Project	---	12
PJEE8406	Comprehensive Viva Voce	---	1
PJEE8404	Internship	---	2
Total (Practical/ Sessional)			**15**
TOTAL			**15**

TOTAL SEMESTER CREDITS: 15

TOTAL CUMULATIVE CREDITS: 160

OPEN ELECTIVE SUBJECTS

OPEN ELECTIVE-IV (OE-IV) 7th Semester						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours**	**Credits**	**Departments to Teach the Subject**	**Students to whom Option is Open**
1	OECH6432	Mineral Processing	3-0-0	3	Chemical Engg.	All branches
2	OECH6433	Colloid and Interfacial Engineering	3-0-0	3	Chemical Engg.	All branches
3	OECE6434	Finite Element Analysis	3-0-0	3	Civil Engg.	All branches
4	OECS6435	Research Methods in Computer Science	3-0-0	3	CSE	All branches
5	OEEE6323	Analog & Digital Communication Systems	3-0-0	3	Electrical Engg.	All branches
6	OEEE6436	Internet of Things	3-0-0	3	Electrical Engg.	All branches
7	OEEC6437	Soft Computing	3-0-0	3	ETC, CSE, Electrical Engg.	All branches
8	OEME6438	Reliability Engineering	3-0-0	3	Mech. Engg.	All branches
9	OEME6439	Robotics	3-0-0	3	Mech. Engg.	All branches
10	OEMT6440	Nanocomposites	3-0-0	3	MME	All branches
11	OEPD6441	Industrial Management	3-0-0	3	Prod. Engg.	All branches

CE:	Civil Engineering	CS, CSE:	Computer Science and Engineering
EE:	Electrical Engineering	EC, ETC:	Electronics and Telecommunication Engineering
ME:	Mechanical Engineering	MT, MME:	Metallurgical and Materials Engineering
CH:	Chemical Engineering	PD, Prod.:	Production Engineering
HM:	Humanities	MA:	Mathematics

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

B.TECH SYLLABUS for ELECTRICAL ENGINEERING

(Admission Batch: 2018-19 Onwards)

7th Semester

PCEE4411	Utilization of Electrical Energy	3-0-0	3 Credits

Course Objectives:

To acquire knowledge on the following topics

1. Energy scenario and consequent growth of the power generation from renewable energy sources
2. Basic physics of solar power generation
3. Basic physics of wind power generation
4. Basic physics of bio-mass power generation
5. Basic physics of hybrid power generation system

Module I **[15 Hours]**

Introduction: Types of Distribution System, The radial systems, the ring main systems, Kelvins law, Loss and factor, Limitation of Kelvin's law.

Distributor: DC distribution fed at one end, 3 wire dc distributor fed from one end, two wire distributor fed at end, uniformly loaded distributor, ring mains.

Ac distribution: Single phase and three phase four wire systems.

Electric drives: introduction Factor affecting selection of motor, type of load ,nature of mechanical load, study state characteristics drives, type of load, d.c motors and ac motors

Module II **[10 Hours]**

Illumination: Definition of illumination flux, the nature of radiation, polar curve-the Rousseau diagram .law of illumination, illumination due to a strip, illumination due to a circular disc, lamination efficacy,

Electrolytic Process: needs of electro chemical deposition, Faraday's law in electro deposition, Extraction of Metals, Refining of Metals, Electro Deposition. Fundamentals of Electro deposition- Laws of electrolytic applications of electrolysis, electro deposition, Anodizing, electro polishing, electro cleaning, electro parting, electrometallurgy.

Module III **[15 Hours]**

Electric Traction: Introduction, Systems of Traction, Systems of electric Traction, Speed - Time Curves for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion. Control of DC Motors, Tapped Field Control or Control by Field Weakening, Multiple Unit Control, Control of Single Phase Motors, Control of Three Phase Motors. System of Electric Traction, AC Electrification, Transmission Lines to Sub - Stations, Sub – Stations, Feeding and Distribution System of AC Traction, Feeding and Distribution System for Dc Tramways, Electrolysis by Currents through Earth, Negative

Booster, System of Current Collection, Trolley Wires.

Text Books:

1. C. L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", Eastern Wiley Ltd.
2. E. O. Taylor, "Utilization of Electrical Energy," Revised in S. I. Units by V. V.I. Rao, Orient Longman

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

1. Understand the energy scenario and consequent growth of the power generation from renewable energy sources.
2. Understand the basic physics of solar power generation.
3. Understand the basic physics of wind power generation.
4. Understand the basic physics of bio-mass power generation.
5. Understand the basic physics of hybrid power generation system.

PCEE4412	High Voltage Engineering	3-0-0	3 Credits

MODULE-1 **[12 HOURS]**

Generation of High Voltages and Currents:

Generation of High Direct-Current voltages. Generation of High Alternating voltage. Generation of High-Frequency AC Voltages. Generation of Impulse voltages and Impulse currents.

MODULE-II **[12 HOURS]**

Conduction and breakdown in gases: Gases as insulating media. Ionization processes. Townsend current growth equation. Current growth in the presence of secondary processes. Townsend's criterion for breakdown. Experimental determination of ionization coefficients. Breakdown in electronegative gases. Time lags for breakdown. Streamer theory of breakdown in gases. Paschen's law. Breakdown in non-uniform field and corona discharges. Post breakdown phenomena and applications, practical considerations in using gases for insulation purposes. Vacuum Insulation.

Conduction and breakdown in liquid dielectrics: Pure liquids and commercial liquids, conduction and breakdown in pure liquids, conduction and breakdown in commercial liquids, Testing of Insulating oils(Transformer oil)

Breakdown in solid dielectrics: Introduction, Intrinsic breakdown. Electromechanical breakdown, Thermal breakdown. Breakdown of solid dielectrics in practice.

MODULE-III **[12 HOURS]**

Measurements of high voltages and currents:

Measurement of high D.C. voltages. Measurement of high A.C. and Impulse voltages. Introduction.. Measurement of high D.C, A.C. and impulse currents, Cathode-Ray Oscillographs for impulse voltages and

currents measurements.

MODULE-IV **[06 HOURS]**

High voltage testing of electrical apparatus:

Testing of insulators and bushings. Testing of isolators and circuit breakers. Testing of cables. Testing of transformers. Testing of Surge Arresters. Radio Interference measurements. Testing of HVDC Valves.

TEXT/REFERENCE BOOKS :

1. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", TMH Publisher.
2. C.L.Wadhwa, "High Voltage Engineering", New Age Internationals Publisher.
3. E. Kuffel and W. S Zaengel,' High Voltage Engineering Fundamentals', Elsevier Publications.

Course Outcomes:

At the end of the course, the student will demonstrate to

1. Know generation of D. C., A.C. & Impulse voltages.
2. Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
3. Know measurement of high voltages and currents.
4. Know tests on H. V. equipment.

PEEE5406	HVDC Transmission Systems	3-0-0	3 Credits

Module 1: **(12 hours)**

DC Transmission Technology

Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVDC Systems. Components of a HVDC system. Line Commutated Converter and Voltage Source Converter based systems.

Analysis of Line Commutated and Voltage Source Converters

Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links.

Module 2: **(12 hours)**

Control of HVDC Converters:

Principles of Link Control in a LCC-HVDC system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link.

Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVDC system: Power flow and dc Voltage Control. Reactive Power

Control/AC voltage regulation.

Module 3: (12 hours)

Converter Faults and Protection:

Converter faults – protection against over current and over voltage in converter station – surge arresters – smoothing reactors – DC breakers –Audible noise-space charge field-corona effects on DC lines- Radio interference.

Reactive Power and Harmonics Control: Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM – Generation of harmonics – Design of AC and DC filters – Active filters

Stability Enhancement using HVDC Control:

Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.

Module 4: (6 hours)

MTDC Links :

Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTDC systems using LCCs. MTDC systems using VSCs. Modern Trends in HVDC Technology. Introduction to Modular Multi-level Converters.

Text/References:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. "HVDC Transmission" By S. Kamakshaiah & V. Kamaraju, TMH Education Private Ltd., 2011, New Delhi.
3. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
4. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Inter science, 1971.

Course Outcomes:

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

1. Understand the advantages of dc transmission over ac transmission.
2. Understand the operation of Line Commutated Converters and Voltage Source Converters.
3. Understand the control strategies used in HVDC transmission system.
4. Understand the improvement of power system stability using an HVDC system.

PEEE5407	Restructured Power Systems	3-0-0	3 Credits

Course Objectives:

1. To impart knowledge about the following topics:
2. To introduce the restructuring of power industry and market models.
3. To impart knowledge on fundamental concepts of congestion management.

4. To analyze the concepts of locational marginal pricing and financial transmission rights.
5. To Illustrate about various power sectors in India

MODULE- I (12Hours)

Introduction to restructuring of power industry:

Reasons for restructuring of power industry; Understanding the restructuring Process, Entities involved, the levels of competition, The market place mechanisms, Sector-wise major changes required; Reasons and objectives of deregulation of various power systems across the world.

Fundamentals of Economics:

Consumer and suppliers behavior, Total utility and marginal utility, Law of diminishing marginal utility, Elasticity of demand and supply curve, Market equilibrium, Consumer and supplier surplus, Global welfare, Deadweight loss

MODULE- II: (12Hours)

The Philosophy of Market Models:

Monopoly model, Single buyer model, Wholesale competition model, Retail competition model, distinguishing features of electricity as a commodity, Four pillars of market design, Cournot, Bertrand and Stackelberg competition model.

Transmission Congestion Management:

Transfer capability, Importance of congestion management, Effects of congestion, Classification of congestion management methods, ATC, TTC, TRM, CBM, ATC calculation using DC and AC model, Nodal pricing, Locational Marginal Prices (LMPs), Implications of nodal pricing, Price area congestion management Capacity alleviation method s, Re-dispatching, Counter-trade, Curtailment

MODULE –III (12Hours)

Ancillary Service Management:

Type and Classification of ancillary services, Sources of reactive power, Black start capability service, Provisions of ancillary services, Markets for ancillary services, Co-optimization of energy and reserve services, Loss of opportunity cost, International practices of ancillary services.

Pricing of transmission network usage and loss allocation:

Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Rolled-in transmission pricing paradigm, Marginal transmission pricing paradigm, Composite pricing paradigm, Merits and de-merits of different paradigms, Classification of loss allocation methods, Pro-rata methods, Incremental methods, Power flow tracing based allocation

MODULE -IV (6 Hours)

Market power and generators bidding:

Attributes of a perfectly competitive market, the firm's supply decision under perfect competition, Imperfect competition, Monopoly, Oligopoly, Electricity markets under imperfect competition Sources of market power, Effect of market power, Identifying market power, HHI Index, Entropy coefficient, Lerner index, Market power mitigation, Effects of contract for differences, Role of demand side bidding, Financial markets,

Introduction to optimal bidding by a generator company

Text Books

1. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured electrical power systems: operation, trading and volatility" Pub., 2001.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.

Reference Books

1. Paranjothi, S.R. **,** **"**Modern Power Systems**"** Paranjothi, S.R. **,** New Age International,2017.
2. Sally Hunt," Making competition work in electricity", John Willey and Sons Inc. 2002.
3. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley & Sons, 2002.

Course Outcomes:

1. This course is intended to provide a comprehensive treatment towards understanding of the new dimensions associated with the power systems.
2. The course will bring out the differences between the conventional power system operation and the restructured one. The course will prepare a background with fundamentals of microeconomics.
3. In this course the design of power markets and market architectural aspects, the changes in operational aspects with new operational challenges like congestion management and ancillary service management will be elaborated.
4. One of the outcomes of the course also efficient pricing of transmission network usage operation and Genco bidding strategies and market power with mitigation techniques.

PCEE5408	Switch Gear and Protective Devices	3-0-0	3 Credits

Module- I **[12 Hours]**

Introduction: Principle and need for protective schemes, Nature and causes of faults, Zones of protection, Primar and back-up protection, Basic principle of operation of protective system, Components of Protection System.

Sequence Components and Fault Analysis: Sequence components (positive, negative and zero) and their significance, Average 3-phase power in terms of symmetrical components, sequence impedance, fault calculations, Single line to ground fault, Line to ground fault with Zf, Faults in Power systems, Concept of short circuit capacity of a Bus.

Module-II **[12Hours]**

Operating Principles and Relay Construction: Relay design and construction, Relay classification, Types of Electromagnetic relays, Theory of Induction relay torque, General Equations of Comparators and Electromagnetic Relays, Over Current relays, Directional relays, Distance relays, Differential relays.
Feeder Protection: Over current, Distance and Pilot Protection.

Static Relays: (Comparators and different relays)
Amplitude comparator, Phase Comparator, Coincidence type phase comparator, Basic elements of a static relay, Over Current Relays, Differential Protection, Static distance Protection.

Module- III [12Hours]

Apparatus Protection: Transformer Protection, Generator Protection, Motor Protection, Bus bar protection schemes.

Numerical relays: Block Diagram of Numerical Relay, Signal Sampling & Processing, Numerical Over-current protection, Numerical Transformer differential Protection, Numerical distance Protection of Transmission Line.

Module- IV [06Hours]

Switchgears: Auto reclosing, Theory of Circuit interruption, Circuit constants in relation to Circuit breaking, Re-striking voltage transient, characteristics of Re-striking Voltage, Interaction between breaker and circuit, Current chopping.

Circuit Breakers: Types of circuit breakers (air blast, air break, oil, vacuum, SF6, DC circuit breaker), advantages and testing of circuit breaker.

Text Book:

1. Power System Protection and Switchgear – B. Ravindranath & M. Chander–New Age International Publishers (Second Edition).
2. Fundamentals of Power System Protection – Y.G.Paithankar and S.R.Bhide, PHI Publication.(Second Edition)
3. Electrical Power System - C.L.Wadhwa New Age International Publishers.(Sixth Edition).
4. Protective Relays-Vol.-I & II, Van C Warrington, John Wiley & Sons Publisher.

Reference Book:

1. Power System Engineering - M.L. Soni, P.V. Gupta, U.S. Bhatnagar, A. Chakrabarti, Dhanpat Rai & Co. (P) Ltd.
2. Power System Protection and Switchgear - Badri Ram, Vishwakarma, Tata McGraw hill.
3. Switchgear and Protection – Sunil S Rao, Khanna Publishers, New Delhi.
4. Power System relaying by Horwitz, Phadke, Research Press.

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

1. Understand the different components of a protection system.
2. Evaluate fault current due to different types of fault in a network.
3. Understand the protection schemes for different power system components.
4. Understand the basic principles of digital protection.

PEEE5409	Advanced Control System	3-0-0	3 Credits

Course Objectives:

1. The course provides glimpses into the advanced methods of modeling and analysis of the dynamical systems
2. The course is a strong step in inculcating the research aptitude in the students

MODULE-I (11 Hours)

Math Modelling of Dynamical Systems: Newtonian and Lagrangian approaches, Concept of dynamical state of a system, Concept of equilibrium point, linearization of non-linear model.

Review of Linear Algebra concepts: Field, Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix, Eigen value and Eigen vector of a matrix, similarity transform, Diagonalisation.

MODULE-II (11 Hours)

Modern Control Analysis: Concept and computation of systems modes, controllability theorem and its proof, Observability theorem and its proof, Controllable and observable subspaces.

Stability Analysis: Stability of linear systems, stability types and their definitions for any general system, Stability of an equilibrium point, Lyapunov stability theory for LTI systems, Quadratic forms and Lyapunov functions.

MODULE-III (10 Hours)

Modern Control Design: Converting the math model to controllable canonical form and its use for pole placement, Concept of linear observer and its design, Design of reduced order observer, Compensator design using separation principle, Poles of compensator, Open loop and close-loop systems.

MODULE-IV (10 Hours)

Optimal Control Theory: Introduction to the philosophy of optimal control, formulation of optimal control problem, different performance criterion, Linear quadratic regulator (LQR) and optimum gain matrix, Riccati equations, conceptual models and statistical models for random processes, Kalman filter.

Suggested reading

1. Bernard Friedland, "Control System Design: An Introduction to State-Space Methods", Dover Publications, Inc. Mineola, New York,2012
2. Thomas Kailath, "Linear Systems", Prentice-Hall Inc., New Jersey,1986
3. M. Gopal, "Modern Control System Theory", , New Age International (P) Limited, New Delhi, 2000

Course Outcomes

Students will be able to

1. Apply the concepts of linear algebra and their applications to control system

2. Analyze the system dynamics and Lyapunov stability theory
3. Design linear quadratic controller

PEEE5415	Renewable Energy Systems	3-0-0	3 Credits

Course Objectives:

To acquire knowledge on the following topics

1. Energy scenario and growth of the power generation from renewable energy sources
2. Basic physics of solar and wind power generation
3. Basic physics of bio-mass power generation
4. Basic physics of hybrid power generation system

Module I **[12 Hours]**

Introduction: Conventional energy Sources and its Impacts, Non-conventional energy– seasonal variations and availability, Renewable energy – sources and features, Distributed energy systems and dispersed generation (DG)

Solar Energy: Solar processes and spectral composition of solar radiation. Solar Thermal system- Solar collectors, Types and performance characteristics, Applications- Solar water heating systems (active & passive), Solar space heating & cooling systems, Solar desalination systems, Solar cooker.

Module II **[12 Hours]**

Solar photovoltaic system-Operating principle, Photovoltaic cell concepts, Cell, module, array, Effects of Shadowing Partial and Complete Shadowing, Series and parallel connections, Cell mismatching, Maximum power point tracking, Applications-Battery charging, Pumping, Lighting, Peltier cooling.

Wind Energy: Wind energy, Wind energy conversion; Wind power density, efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, Types of Turbine, Turbine rating. Choice of generators, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems .

Module III **[12 Hours]**

Conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation, Characteristics of wind power plant, Concept of DFIG.

Biomass Power: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Types of biogas digester, Wood gassifier, Pyrolysis, Applications. Bio gas, Wood stoves, Bio diesel, Combustion engine, Application.

Module IV **[6 Hours]**

Hybrid Systems: Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles.

Text Books:

1. Renewable Energy- Power for a Sustainable Future, Godfrey Boyle, Oxford University Press
2. B.H.Khan, Non-Conventional Energy Resources, Tata McGrawHill, 2009
3. S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Univ. Press, New Delhi, 2005.

Reference Books:

1. S. A. Abbasi, N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, New Delhi, 2006.
2. G.D. Rai, " Non-Conventional Sources of Energy", Khanna Publishers

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

1. Understand the energy scenario and growth of the power generation from RES.
2. Understand the basic physics of solar and wind power generation**.**
3. Understand the basic physics of bio-mass power generation.
4. Understand the basic physics of hybrid power generation system.

HONOURS

HNEE0405	Power Plant Engineering	3L-1T-0P	4 Credits

Course Objectives:

To impart knowledge about the following topics:

1. Introduce the students to various electrical energy sources, loads.
2. Study of power generation economics.
3. Study about Nuclear, Hydel and Thermal power Station.

MODULE I **(12Hours)**

Introduction to different sources of energy and general discussion on their application to generation, Indian Energy Scenario.

Prediction of Load, Connected Load, Maximum Load, Demand Factor, Average load, Load Factor, Load duration curves, Diversity Factor, Choice of Type of Generation, Capacity Factor, Reserve Factor, Plant Use Factor, Base Load, Intermediate Load and Peak Load Plants.

Economics of power generation: Cost of Electrical Energy, Construction costs, Fixed cost, Costs for Energy, Depreciation of Plant, Fuel cost, Economic scheduling principle, Annual Operating Costs, Effect of Load Factor on cost per kWh, Tariff or Charge to Consumer.

MODULE II (12 Hours)

Thermal power station:

Selection of site for thermal power plant. Overall Block Diagram indicating the air circuit, coal and ash circuit, water and steam circuit, various types of steam turbines, ash and coal handling system, High Pressure and High capacity water tube boilers, Economizer, Super heaters, De-Super heater, Re-heater, Air Pre-heater.

Draft System: Natural, Induced Forced and Balance Draft, PA fan, FD fan, ID fan, Chimney. Condensers, Feed water heaters, Evaporators, Make-up water, bleeding of steam, cooling water system. Electrostatic Precipitator: Basic working Principle and constructional details Governors, Plant auxiliaries.

MODULE III (12Hours)

Hydel power station:

Selection of site for hydro-electric power plant.

Hydrology: Hydrological cycle, precipitation, run-off and its measurement, hydrograph, flow duration and mass curves, Estimation of amount stored by a dam across the river, Storage and Pondage, Elementary idea about Earthen and Concrete Dam.

Turbines: Operational principle of Kaplan and Francis Turbine and Pelton wheel, Speed and Pressure Regulation, Work done and Efficiency.

Essential Elements of a Hydro-electric Power Plant: Catchment area, Reservoir, Dam, Head Gate, Spillways, Pen stock, Surge Tanks, Scroll case, Draft tubes and Tail Race, Power House, Classification of Hydroelectric Power Plants. Governors, Plant auxiliaries.

MODULE IV (6Hours)

Nuclear power station:

Introduction to fission & fusion, Principle of Nuclear Energy, Reactor Construction, Controlled Chain Reaction, Brief study of various Types of Power Reactor, Operational Control of Reactors, Location and layout of nuclear power plant, Economics of Nuclear Power Station.

Text books:

1. P. K. Nag, "Power Plant Engineering", 3rd Edition, Tata McGraw Hill Publication.
2. M. V. Deshpande, "Elements of Electrical Power Station Design", PHI.

References books:

1. Arora & Domkundwar, "A Course in Power Plant Engineering", Dhanpat Rai and sons.
2. R. K. Rajput, "A Text Book of Power Plant Engineering", 3rd Edition, Laxmi Publishing.
3. Bernhardt G. A. Skrotzki, William A. Vopat, "Power Station Engineering and Economy", 2nd Edition, Tata McGraw Hill Publication.

Program Outcomes:

At the end of the course the students have the ability to;

1. Analyze the various electrical load characteristics.

2. Investigate the various power system economics.
3. Able to understand various aspects of Power Stations.

MINOR

MNEE0405	Switch Gear and Protective Devices	3-1-0	4 Credits/

Course Objectives:

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

1. Understand the different components of a protection system.
2. Evaluate fault current due to different types of fault in a network.
3. Understand the protection schemes for different power system components.
4. Understand the basic principles of digital protection.

Module- I **[12 Hours]**

Introduction: Principle and need for protective schemes, Nature and causes of faults, Zones of protection, Primar and back-up protection, Basic principle of operation of protective system, Components of Protection System.

Sequence Components and Fault Analysis: Sequence components (positive, negative and zero) and their significance, Average 3-phase power in terms of symmetrical components, sequence impedance, fault calculations, Single line to ground fault, Line to ground fault with Zf, Faults in Power systems, Concept of short circuit capacity of a Bus.

Module-II **[12Hours]**

Operating Principles and Relay Construction: Relay design and construction, Relay classification, Types of Electromagnetic relays, Theory of Induction relay torque, General Equations of Comparators and Electromagnetic Relays, Over Current relays, Directional relays, Distance relays, Differential relays.
Feeder Protection: Over current, Distance and Pilot Protection.

Static Relays: (Comparators and different relays)
Amplitude comparator, Phase Comparator, Coincidence type phase comparator, Basic elements of a static relay, Over Current Relays, Differential Protection, Static distance Protection.

Module- III **[12Hours]**

Apparatus Protection: Transformer Protection, Generator Protection, Motor Protection, Bus bar protection schemes.

Numerical relays: Block Diagram of Numerical Relay, Signal Sampling & Processing, Numerical Over-current protection, Numerical Transformer differential Protection, Numerical distance Protection of Transmission Line.

Module- IV **[06Hours]**

Switchgears: Auto reclosing, Theory of Circuit interruption, Circuit constants in relation to Circuit breaking, Re-striking voltage transient, characteristics of Re-striking Voltage, Interaction between breaker and circuit, Current chopping.

Circuit Breakers: Types of circuit breakers (air blast, air break, oil, vacuum, SF6, DC circuit breaker), advantages and testing of circuit breaker.

Text Book:

1. Power System Protection and Switchgear – B. Ravindranath & M. Chander–New Age International Publishers (Second Edition).
2. Fundamentals of Power System Protection – Y.G. Paithankar and S.R. Bhide, PHI Publication.(Second Edition)
3. Electrical Power System - C.L. Wadhwa New Age International Publishers.(Sixth Edition).
4. Protective Relays-Vol.-I & II, Van C Warrington, John Wiley & Sons Publisher.

Reference Book:

1. Power System Engineering - M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti,DhanpatRai& Co. (P) Ltd.
2. Power System Protection and Switchgear - Badri Ram, Vishwakarma, TataMcGraw hill.
3. Switchgear and Protection – Sunil S Rao,Khanna Publishers, New Delhi.
4. Power System relaying by Horwitz, Phadke, Research Press.

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

1. Understand the different components of a protection system.
2. Evaluate fault current due to different types of fault in a network.
3. Understand the protection schemes for different power system components.
4. Understand the basic principles of digital protection.

OPEN ELECTIVE-IV (OE-IV) 7th Semester

OECH6432	Mineral Processing	3L-0T-0P	3 Credits

Objectives of the Course:

1. This course will brief about how most of the ores undergo after mining in order to provide a more concentrated material for the procedures of extractive metallurgy.
2. It gives the preliminary idea about the primary operations such as comminution and concentration.
3. This course will also provide the information about a modern mineral processing plant, including sizing, sampling and bulk material handling.

Module-I: **(4 weeks/12 Hours)**

Unit I: Comminution: Fundamentals of Rock Breakage, Energy Estimations, Liberation, Reduction Ratio, Primary Crushers, Secondary Crushers, Circuits, Selection Criterion. Grinding Mills, Critical Speed, Recent Developments & Mass Balancing (Importance, Techniques, Numerical Examples and their Relevance

Unit II: Industrial Screening: Applications, Basic Design Features, Types of Screens, Performance Evaluation and Factors Affecting Performance. Movement of Solids in Fluids: Equation of Motion, Drag Curve, Free & Hindered Terminal Settling Velocities in Gravitational and Centrifugal Force Fields, Applications & Classifiers (Various Types and Their Applications).

Module-II: **(4 weeks/12 Hours)**

Unit III: Hydrocyclone: Principles of Operation, Design Variables, Operating Variables, Performance Evaluation of Hydrocyclone, Control of Cyclone Operation, Recent Developments.

Unit IV: Gravity Concentration: Fundamentals, Flowing Film Type, Static Bath Type, Jigging, Centrifugal & Enhanced Gravity Type Concentrators.

Module-III: **(4 weeks/12 Hours)**

Unit V: Flotation: Fundamentals, Role of Reagents, Flotation Machines, and Applications.

Unit VI: Bulk Material Storage and Handling: Properties of Bulk Solids, Measurements, Storage, Flow Modes, Silos, Bins and Hopper Design, Common Problems.

Module-IV: **(2 weeks/6 Hours)**

Unit VII: Slurry Transportation: Pipe Line Flow, Mixture properties, Design perspective, Influence of several factors, Basic calculations, Case studies.

Books for Reference:

1. Mineral Processing Technology by B.A.Wills and Tim Napier-Munn.
2. Principal of Mineral Dressing by A.M. Gaudin – McGraw Hill Company, 1971.
3. Jain, S.K., Ore Processing, Oxford – IBH Publishing, 1984.
4. Taggart, A.F., Handbook of Mineral Dressing, John Wiley and Sons, New York, 1990.
5. Wills, B.A. Mineral Processing Technology, Pergamon Press, 1985.
6. Vijayendra, H.G., Handbook on Mineral Dressing, Vikas Publishing House Pvt. Ltd. 1995.

Course Outcomes:

At the end of the course, the students should be able to

1. Solve problem related to changes in size and shape of the mineral.
2. Understand briefly about the operation of a mineral plant
3. Can handle problem related to material transportation, material handling and storage.

OECH6433	Colloid and Interfacial Engineering	3L-0T-0P	3 Credits

Objective of the course: To provide comprehensive knowledge on concepts and principles of colloids, interfaces and their applications.

Module-I (12 Hours/4 Weeks)

Unit – 1 (6 Hours/2 Weeks) General introduction of colloids, interfaces, surfactants, and micellization. Intermolecular forces, van der Waals' forces (Keesom, Debye, and London interactions).

Unit – 2 (6 Hours/2 Weeks) Colloidal systems and colloidal stability (van der Waals' attraction and potential energy curves). Brownian motion and Brownian flocculation.

Module-II (12 Hours/4 Weeks)

Unit – 3 (6 Hours/2 Weeks) Surface and interfacial tension and surface free energy. Surface tension for curved interfaces.

Unit – 4 (6 Hours/2 Weeks) Surface excess and Gibbs equation. Theory of surface tension, contact angle, and wetting.

Module-III (12 Hours/4 Weeks)

Unit – 5 (6 Hours/2 Weeks) Thermodynamics of interfaces, thermodynamics of micelle and mixed micellar formation.

Unit – 6 (6 Hours/2 Weeks) Electrical phenomena at interfaces (Electro kinetic phenomena, Electrical double layer). Emulsion and micro emulsion, General applications.

Module-IV (6 Hours/2 Weeks)

Unit –7 (6 Hours/2 Weeks) Enhanced petroleum recovery, super hydrophobic and self-cleaning surfaces. Novel fabrication of nano-structured particles. Measurement techniques of surface tension, Contact angle, Zeta potential, Particle size.

Text Books

1. Principles of Colloid and Surface Chemistry, 3rd ed. by P CHiemenz and R Rajagopalan, Mercel Dekker.
2. Introduction to Colloid & Surface Chemistry, 4th ed. by D J Shaw, Butterworth Heinemann.
3. Colloid and Surface Chemistry by P. Somasundaran, Create Space Independent Publishing Platform.
4. Introduction to Applied Colloid and Surface Chemistry by G. M. Kontogeorgis and S. Kiil, John Wiley & Sons.

Course Outcomes:

At the end of the course, the student should be able to

1. Understand the colloidal science engineering fundamentals.
2. Characterize interfaces and surface phenomena.

OECE6434	Finite Element Analysis	(3-0-0)	Credit-03

Module I:

Introduction: The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Different methods of structural analysis including numerical methods. Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method.

Module II:

One and Two Dimensional Problems: Detail formulation including shape functions. stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, Assembling of element matrices, application of displacement boundary conditions, Numerical solution of one dimensional problems using bar, truss, beam elements and frames. Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria.

Module III:

Finite Element modeling of two dimensional problems using Constant strain Triangle (CST) elements, Stress strain relations for isotropic and orthotropic materials, Four nodded rectangular elements, axisymmetric solids subjected to axisymmetric loading.

Isoparametric Elements: Natural coordinates, isoparametric elements, four node, eight node elements. Numerical integration, order of integration.

Module IV:

Plate Bending: Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modeling.

Text Books:

1. C. S. Krishnamoorthy, Finite Element analysis-Theory and Programming, TMH
2. Finite Element Method, R. Dhanraj and K. P. Nair, Oxford University Press
3. Finite Element Methods for Engineers by U.S. Dixit, Cengage Learning

Reference Books:

1. R. D. Cook., Concepts and Applications of Finite Element Analysis, Wiley.
2. M. Mukhopadhyay-Matrix and Finite Element Analysis of Structures
3. O. C Zienkiewicz .and R. L. Taylor, Finite Element Method, McGraw Hill
4. Introduction to Finite Elements in Engineering, T.P. Chandrupatla and A.D. Belegundu
5. Finite Element Analysis in Engineering Design, S. Rajasekharan.

OECS6435	Research Methods in Computer Science	(3-0-0)	Credit-03

Prerequisites:

The course does not have any formal prerequisites. You must have a research project in sufficient maturity so you can finish a meaningful portion of your research and a complete paper by the end of the semester. The research topic can be a portion of your BTech, MCA, MS, MTech or PhD thesis project, a significant extension of course projects from the past, or something you are passionate about. This course is most appropriate for graduate students who are interested in research but do not have extensive prior research experience.

Course Objectives:

1. To introduce research and research methodologies in CS to students going to peruse research in CS.
2. To understand the strengths and weakness of each of these methods.
3. How to choose suitable method(s) for the investigations?
4. How to carry out investigations using these methods?
5. What are the threats associated with these methods and how to deal with them.
6. Reporting the results of these investigations. Writing technical articles/research papers.
7. Understanding roles of authors, reviewers. How to review research articles?

Module I: **10 Hrs.**

Introduction to Research, Research Methods in Computer Science, Analytical vs. Empirical Methods, Surveys, Case Studies, Controlled Experiments, Ethnography and Action Research, Quantitative, Qualitative, and Mixed Methods, Choosing research methods, Validity threats, Meaning of Research Problem, Data collection methods - primary and secondary sources, Types of data analysis methods, Analysis and Interpretation of Quantitative Data, Descriptive Statistics, Sampling, sampling distribution, Parameter Estimation, Statistical Inference, confidence interval and Hypothesis Testing using normal distribution, Tests of significance, test of difference of mean and proportions, t-tests, ANOVA, Chi-square Tests, correlation and regression, Review Process, Review guidelines, Validity threats, Review decisions, Research Qualitative Methods, Study Designs, Elements, and Methods, The nature and types of qualitative research, Study Designs, Elements, and Methods, The nature and types of qualitative research, problem definition, Sources of research problem, Scope and objectives of research problem, Criteria characteristics of a good research problem, Errors in selecting a research problem, Approaches of solutions for research problem, Necessary Instrumentation, use of SPSS package.

Module II: **10 Hrs.**

Survey Research, Sampling Methods, Survey Study Designs, Case Studies, Introduction to Mixed Methods Research, Study Designs and Method, An Empirical Research Framework, Research Problems, Literature Reviews, Study Designs, Controlled Experiments, Elements and Methods Example Experiments Effective literature studies approach, Analysis, Plagiarism, Research Ethics, Effective technical writing, How to write report, paper, Developing a research proposal, Format of research Proposal, A presentation and assessment by a review committee, IEEE guidelines for writing abstract, journal papers, power point presentation, thesis and project report, Writing research papers, purpose, nature and evaluation, content and format, Research Presentations, The Art of Scientific and Technical Writing.

Module III: **10 Hrs.**

Nature of Intellectual property, Patents, Design, Trade and copy right, Process of patenting and development, Technological research, innovation, patenting, development, International scenarios: International cooperation on intellectual property, Procedure for grants of patents, Patenting under PCT, use of **Turnitin** service.

Module IV: **10 Hrs.**

Patent rights: Scope of patent rights, Licensing and transfer of technology, Patent information and databases, Geographical Administrations, New Developments in IPR, Administration of patent system, New Development in IPR: IPR of biological system, software etc., Traditional knowledge case studies, IPR and IITs, case studies

Text Book:

There is no text book for the course. A teacher may use lecture notes and videos, read research papers and Web Pages, which will be freely available on internet websites.

Reference books:

1. Research Design. Qualitative, Quantitative, and Mixed Methods Approaches. By John W. Creswell, Fourth Edition. SAGE Publication, 2014
2. The Craft of Research, By Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, William T. FitzGerald, Third Edition, The University of Chicago Press, 2008
3. The Elements of Style. William Strunk Jr. and E. B. White, Forth Edition, Pearson, 1999
4. Research Methodology By Panneerselvam R, 2nd Edition, PHI, 2014
5. Statistical Design and Analysis of Experiments With Applications to Engineering and Science, Robert L. Mason, Second Edition, Wiley Inter Science.[Good for Data Analysis and Hypothesis Testing]
6. THE DESIGN OF DESIGN: ESSAYS FROM A COMPUTER CIENTIST, Frederick P. Brooks Jr., Addison-Wesley Professional, 2010.

OEEE6323	Analog and Digital Communication Systems	3-0-0	Credit-3

Course Objectives:

1. Introduction to analog and digital communication systems.
2. Analysis of signal in frequency domain.
3. Study of analog modulation schemes.
4. Study of digital modulation techniques

Module I **(12 Hours)**

Elements of Communication System-Analogue System, Digital System, Distinguishing features. Electromagnetic Spectrum, Bandwidth. Comparison between Analog & Digital Communication Systems. Frequency domain analysis of signals and systems: Fourier series, Fourier Transforms, Power and Energy, Sampling and Band limited signals, Band pass signals.

Module II **(12 Hours)**

Introduction to modulation, Amplitude Modulation (AM),Depth of Modulation, Modulated Waveform, Powers in Carrier, and Sidebands, Generation of DSBC and SSB, Balanced Modulator, AM Demodulators. Frequency Modulation (FM) - Frequency Deviation, Frequency Modulated Waveform, Spectrum. Narrow Band FM and Wideband FM. Generation of FM; Narrow Band FM Modulator, Wideband FM Modulator, FM Discriminator, Angle Modulation.

Module III **(12 Hours)**

Pulse modulation systems: Pulse amplitude modulation, Pulse Time Modulation. Pulse code modulation: PCM system, Inter symbol interference, Time Division Multiplexing of PCM signals, Line codes, Bandwidth of PCM system, Noise in PCM systems, Delta Modulation (DM), Limitations of DM, Adaptive Delta Modulation, Noise in Delta Modulation, Comparison between PCM and DM, Delta or Differential PCM (DPCM), S-Ary System.

Module IV **(6 Hours)**

Digital Modulation Techniques. Phase Shift Keying (PSK), Frequency Shift Keying (FSK) – their Basic Principle, Waveform, Generation and Detection. Ideal low pass, Band pass and Band rejection filters – their impulse response (no mathematical derivation).

Program Outcomes:

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

1. Analyse signals in frequency domain.
2. Analyze and compare different analog modulation schemes for their efficiency and bandwidth.
3. Analyze different digital modulation schemes.
4. Investigate pulsed modulation system and analyze their system performance.

TEXT BOOKS:

1. John G.Proakis, M. Salehi, COMMUNICATION SYSTEMS ENGINEERING, 2nd ed. New Delhi, India: PHI Learning Private Limited, 2009.
2. R.P Singh and S.D Sapre, COMMUNICATION SYSTEMS Analog & Digital, 2nd ed. New Delhi, India: Tata McGraw Hill Education Private Limited, 2009.
3. Martin S. Roden, "Analog and Digital Communication Systems", SPD Publisher.

REFERENCE BOOKS:

1. H.Taub and D. L. Shilling, "Principle of Communication System", TMH Publisher.
2. Modern Digital and Analog Communication Systems, by B.P. Lathi, Oxford.

OEEE6436	Internet of Things	3-0-0	3 Credits

Course Objectives:

1. To understand the design of IOT relevant applications in various domain.
2. To understand the concepts of Raspberry Pi, interfaces and applications in IoT domain.
3. To understand the importance of cloud computing and its applications.
4. To understand specific security and data protection issues in IoT

MODULE-I **(12 Hours)**

Unit 1

Introduction & Concepts: Introduction to Internet of Things, Physical Design of IOT, Logical Design of IOT, IOT Enabling Technologies, IOT Levels.

Unit 2

Domain Specific IOTs: Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Life Style. Smart Lighting, Intrusion Detection, Smoke/Gas Detectors, Cities-Smart Parking, Smart Lighting, Smart Roads, Environment-Weather Monitoring, Air pollution Monitoring, Forest Fire Detection, Energy-Smart Grids, Logistics-Route Generation & Scheduling, Agriculture Smart Irrigation, Health & Fitness Monitoring.

MODULE-II **(12 Hours)**

Unit 3

M2M: M2M, Difference between IOT and M2M.

Unit 4

IOT Physical Devices & Endpoints: What is an IOT Device, Linux on Raspberry Pi, Interfaces,

Programming: Installing python. Data types and data structures, Flow, Functions, Modules, File Handling, Date/ Time Operations, Classes, Python Packages.

MODULE-III **(12 Hours)**

Unit 5

Design steps of IoT

Design steps of IoT**,** Raspberry Pi, About the Board, Linux on Raspberry Pi.

Unit 6

Raspberry Pi Interfaces – Serial, SPI, I2C, Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi, interfacing an LED and Switch with Raspberry Pi, Interfacing a Light Sensor (LDR) with Raspberry Pi.

MODULE-IV **(8 Hours)**

Unit 7

Privacy and Security threats on internet of Things: Specific security and data protection issues, IoT privacy

and security issues in smart cities.

Text Book:

1. Arshdeep Bahga and Vijay Audisetti, "Internet of Things, A Hands on Approach", University Press, 1st edition, 2016.

Reference Books:

1. Sébastien Ziegler, "Internet of Things Security and Data Protection", Springer Publisher, 1st edition, 2019.
2. Adrian McEwen, "Designing the Internet of Things", Wiley, 1st edition, 2015.
3. Miller, "The Internet of Things: How Smart TVs, Smart Cars, Smart Homes and Smart Cities are Changing the World", Pearson, 1stedition, 2015.

Course Outcomes:

1. To analyse applications of IOT in various domain.
2. To realize the revolution of Internet in Mobile Devices, Cloud &Sensor Networks
3. To understand the importance of cloud computing and Embedded system.
4. To understand the challenges and limitations of internet of things.

OEEC6437	Soft Computing	3-0-0	Credits 3

COURSE OBJECTIVES

1. To familiarize with soft computing concepts.
2. To introduce the fuzzy logic concepts, fuzzy principles and relations.
3. To know the basics of ANN and Learning Algorithms.
4. To analyze Ann as function approximation.
5. To know Genetic Algorithm and its applications to soft computing.
6. To analyze Hybrid system usage, application and optimization

MODULE-I (10 Hours)

Unit-1

Introduction

What is Soft Computing? Difference between Hard and Soft computing, Requirement of Soft computing, Major Areas of Soft Computing, Applications of Soft Computing.

Unit-2

Fuzzy Systems

Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

MODULE-II (12 Hours)

Unit-3

Neural Networks

What is Neural Network, Learning rules and various activation functions, Single layer Perceptron, Back Propagation networks, Architecture of Backpropagation (BP) Networks, Backpropagation Learning, Variation of Standard Back propagation Neural Network.

Unit-4

Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.

MODULE-III (10 Hours)

Unit-5

Genetic Algorithm

History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function.

Unit-6

GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization.

MODULE-IV (10 Hours)

Unit-7

Hybrid Systems

Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.

GA based Backpropagation Networks

GA based Weight Determination, K - factor determination in Columns.

Fuzzy Backpropagation Networks

LR type Fuzzy numbers, Fuzzy Neuron, Fuzzy BP Architecture, Learning in Fuzzy BP, Application of Fuzzy BP Networks.

Text Books:

1. S, Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications, PHI Publication, 1st Edition, 2009.
2. F. O. Karry and C. de Silva, "Soft Computing and Intelligent Systems Design – Theory, Tools and Applications", Pearson Education.

Reference Books:

1. J. S. R. Jang. C. T. SUN and E. Mizutani, "Neuro-fuzzy and soft-computing". PHI Pvt. Ltd., New Delhi.
2. Fredric M. Ham and Ivica Kostanic, "Principle of Neuro Computing for Science and Engineering", Tata McGraw Hill.
3. S. Haykins, "Neural networks: a comprehensive foundation". Pearson Education, India.
4. V. Keeman, "Learning and Soft computing", Pearson Education, India.
5. R. C. Eberhart and Y. Shi, "Computational Intelligence Concepts to Implementation". Morgan Kaufmann Publishers (Indian Reprint).

6. David E. Goldberg, "Genetic Algorithms in search, optimization, and machine learning", Addison-Wesley Publishing Company, Inc, 1989.

Course Outcomes:

1. To analyze the facts and outline the different process carried out in fuzzy logic, ANN and Genetic Algorithms.
2. To understand the concepts and meta-cognitive of soft computing.
3. To Apply Soft computing techniques the solve character recognition, pattern classification, regression and similar problems.
4. To identify process/procedures to handle real world problems using soft computing.
5. To apply various techniques of soft computing to defend the best working solutions.
6. To Design hybrid system to revise the principles of soft computing in various applications.

OEME6438	Reliability Engineering	3-0-0	Credit-3

OBJECTIVES:

To stress the importance of reliability in Engineering and products also the concept of maintainability, failure modes and testing methods.

UNIT I: CONCEPTS OF RELIABILITY, SYSTEM AND MODELS [12 Hours]

Definition of reliability – reliability Vs quality-reliability function-MTTF – hazard rate function- bathtub curve – derivation of the reliability function-constant failure rate model – time dependent failure models. Weibull distribution – normal distribution – the lognormal distribution. Serial configuration – parallel configuration – combined series parallel systems – system structure function, minimal cuts and minimal paths – Markov analysis – load sharing systems, standby system, degraded systems, three state devices – covariate models, static models, dynamic models, physics of failure models.

UNIT II : DESIGN FOR RELIABILITY AND MAINTAINABILITY [12 Hours]

Reliability design process – system effectiveness – economic analysis and life cycle cost – reliability allocation – optimal, Arinc, Agree, – Design methods – parts and material selection, derating, stress- strength analysis – failure analysis – identification of failure mode – determination of causes –assessment of effects – classification of seventy – computation of critically index – corrective action – system safety and FTA. Analysis of downtime – the repair time distribution – stochastic point processes – system repair time – reliability under preventive maintenance – state dependent systems with repair – MTTR-mean system downtime – MTR – MH/OH – cost model – fault isolation and self-diagnostics – repair Vs replacement – replacement model – proactive, preventive, predictive

Maintenance – maintenance and spares provisioning – maintainability prediction and demonstration – concepts and definition of availability.

UNIT III: OPTIMIZATION OF SYSTEM RELIABILITY [7 Hours]

Optimization techniques for system reliability with redundancy – heuristic methods applied to optimal system reliability- redundancy allocation by dynamic programming – reliability optimization by non linear programming.

TEXT BOOKS:

1. Charles E. Ebling, "An introduction to Reliability and Maintainability Engg", Tata McGraw-Hill, 2000.

REFERENCES:

1. Patrick D T O'Connor, "Practical Reliability Engineering", John-Wiley and Sons inc, 2002.
2. David J Smith, "Reliability, Maintainability and Risk: Practical Methods for Engineers", Butterworth, 2002
3. Way kuo, Rajendra Prasad V, Frank A and Tillman, ching- lai Hwang "Optimal Reliability Design and Applications", Cambridge University Press P ltd., 2001.
4. Srinath I.S, Engineering Design and Reliability, ISTE, 1999.
5. Oleg Vinogradov, "Introduction to Mechanical Reliability: A Designers Approach, Hemisphere Publications, 1991.

OUTCOMES

The Student must apply and optimize reliability for time independent and time dependent failure models through various testing methods for various manufacturing amnesty process

OEME6439	Robotics	3-0-0	Credit-3

Course objective:

To expose students to the automation, robot kinematics and robot arm dynamics. To acquire knowledge on Classification and structure of robotic system, robot programming and its applications.

Module I **(13 Hours)**

Introduction, Automation and Robotics, brief history, Social and economic aspects, Advantages overview of robots and future application; Classification & structure of robotic system: Classification, Configuration, wrist, end effectors, Links, Joints, Drive system; Control System: Basic control system concepts, model, transformation and block diagrams, controllers ON & OFF, transient response.

Module II **(11 Hours)**

Robot Kinematics: Direct & inverse kinematics, rotation matrix, composite rotation matrix, homogenous transformations, links, joints D-H representation, Geometrical approach of direct & reverse kinematics; Robot Arm dynamics: Joint velocities, KE, PE & motion equation of manipulating trajectory planning, joint interpolated trajectory

Module III **(9 Hours)**

Robot Programming: Languages, Graphics, Storing & operating, Task programs; Sensors: State and external state sensors, tactile and non-tactile sensors, force – torque sensors, Image processing & analysis, Computer vision.

Essential Reading:

1. Groover, Industrial Robot, PHI. 2. Y. Korem, Robotics, Mc Graw-Hill.

Course Outcomes:

1. Complete knowledge of robotic system
2. Idea about robot kinematics and robot arm dynamics
3. Learning of robot languages and the use of sensors

OEMT6440	Nanocomposites	3-0-0	Credits 3

Objectives of the Course:

To become familiar with nanocomposite processing, properties and their applications in the engineering.

Module-I: (12 hours)

Introduction to nanocomposites, composite materials, mechanical properties of nanocomposite materials, stress strain relationship, toughness, strength, plasticity, Ceramic matrix nanocomposites, Different types, Synthesis (Conventional powder method; Polymer precursor route; Spray pyrolysis; Vapour techniques (CVD and PVD) and Chemical methods, which include the sol-gel process, colloidal and precipitation approaches and the template synthesis). Structure, Properties and New Application

Module-II: (10 hours)

Metal matrix nanocomposites, Different types, Synthesis (Spray pyrolysis; Liquid metal infiltration; Rapid solidification; Vapour techniques (PVD, CVD); Electro deposition and Chemical methods, which include colloidal and sol-gel processes), Structure, Properties and New Application, ceramic-metal nanocomposites, Different types, Synthesis, Structure, Properties and New Application

Module-III: (10 hours)

Polymer Matrix nanocomposites (PMNC): Different types synthesis (Intercalation / Prepolymer from Solution In-situ Intercalative Polymerization, In situ polymerization Mixing, Melt Intercalation), structure, Properties and New Application

Module-IV: (10 hours)

Carbon nanotubes Nanocomposites: Different types, Synthesis, Structure, Properties and New Application, Natural nano-biocomposites, bio-mimetic nanocomposites and biologically inspired nanocomposites: Different types, Synthesis, Structure, Properties and New Application

Suggested Reference Books:

1. P. M. Ajayan, L. S. Schadler and P. V. Braun, Nanocomposite Science and Technology, Wiley-VCH, 2003.
2. C. P. Poole and F. J. Owens, Introduction to Nanotechnology, Wiley Interscience 2003.
3. H. S. Nalwa, Encyclopaedia of Nanotechnology, 2004.

4. Chung; Deborah D. L., Composite Materials: Science and Applications, Spinger International Edition, Springer-Verlag, London (2004)-Indian Edition 2006.

Course Outcomes:

1. Students will be able to identify nanocomposites for a given application
2. Understanding properties of a nanocomposite by relating them to its structure
3. Identifying a suitable nanocomposite process for a given application
4. Applying nanocomposite fundamentals in real life situations

OEPD6441	INDUSTRIAL MANAGEMENT	3L-0T-0P	3 Credits

Course Objective

The objective of this course is to produce graduates who Contribute to the success of companies through effective problem solving. Design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and environments.

Module I **[12]**

Basic Management Theory: Evolution of Management Thought, Scientific Management, Organization as a System, Function of Management, Principles of Management, Planning, Decision Making, Organizing Principle, Delegation of Authority, Line and Staff Function, Leadership, Motivation, Communication, Controlling.

Module II **[10]**

Personnel Management: Organization as Social System, Motivation and Behaviour, Role of Personnel Management, Recruitment, Selection, Training, Performance Appraisal, Job Evaluation and Merit Rating, Wage Policy, Incentives, Group Dynamics, Job Satisfaction and Morale.

Materials Management: Purchasing, Selection of Vendor, Learning Curve Concept, MRP.

Module III **[10]**

Marketing Management: Selling and Marketing Concept, Role of Marketing Management in the Process of Marketing Management, Product Life Cycle, New Product Development Strategy, Market Research, Consumer Behaviour, Sales Promotion Advertising, Pricing Strategy, Break even analysis, Channel of Distribution.

Module IV **[08]**

Financial Management: Scope, Time Value of Money, Depreciation cost of a product, Financial Statement Analysis, Ratio Analysis, Working Capital, Sources of Finance.

Industrial Relation: Trade Union, Industrial Dispute, Workers Participation In Management, Industrial Legislation, Labour Law, Factory Act.

Text Books:

1. Industrial Engineering & Production Management, M. Mahajan, Dhanpat Rai Publication.
2. Industrial Engineering & Management Science, T. R. Banga, N. K. Agarwal, S. C. Sharma, Khanna Publication.

Reference Books:

1. Personnel Management, A. Mannappa, M. S. Saiyadain.
2. Fundamentals of Financial Management, Prasanna Chandra, TMH.

Course Outcomes:

Upon successful completion of the course, student will able to:

1. Understand the theories and principles of modern management.
2. Apply the concepts to the management of organisations in private and public sector
3. Understand how managers can effectively plan in today's dynamic environment.
4. Be familiar with the design of organisation structure.
5. Describe how environmental uncertainty affects organisation design

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

B.TECH SYLLABUS for ELECTRICAL ENGINEERING

(Admission Batch: 2018-19 Onwards)

8th Semester

PEEE5410	Energy Audit and Management	3-0-0	3 Credits

Module 1: **[12 Hours]**

Energy Scenario

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Basics of Energy and its various forms

Electricity tariff, load management and maximum demand control, power factor improvement, selection &location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Module II: **[12 Hours]**

Energy Management & Audit

Definition, need of energy audit, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Module III: **[12 Hours]**

Energy Efficiency in Electrical Systems

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.

Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Energy Efficient Technologies in Electrical Systems

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Module IV: **[06 Hours]**

Energy Efficiency in Industrial Systems

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC,

Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Text/Reference Books

1. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors (Book 1-available online).
3. Guide books for National Certification Examination for Energy Manager / Energy Auditors (Book 3-available online)

Course Outcomes:

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

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Understand the methods of improving energy efficiency in different electrical systems.
4. Understand the concepts of different energy efficient devices.

PEEE5411	Smart Grid	3-0-0	3 Credits

Course Objectives:

Students will be able to:

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

Module-1 **(8 Hour)**

Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self-Healing Grid Present development & International policies in Smart Grid.

Module-II **(12 Hour)**

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR),Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation 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).

Module-III **(11 Hour)**

Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of micro-grid, Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines, Captive power plants, Integration of renewable energy source, 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.

Module-IV **(11 Hour)**

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area, Network (NAN), Wide Area Network(WAN),Bluetooth, Zig Bee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid, Broadband over Power line(BPL),IP based protocols.

Suggested reading

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE,2011
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press,2009
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "Smart Grid: Technology and Applications", Wiley2012
4. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions " CRC Press
5. A.G. Phadke, "Synchronized Phasor Measurement and their Applications", Springer

Course Outcomes:

Students will be able to:

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

PEEE5412	Electrical and Hybrid Vehicles	3-0-0	3 Credits

Course Objectives:

1. To understand upcoming technology of hybrid system
2. To understand different aspects of drives application learning the electric Traction.

Module-1 **(12 Hour)**

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics, models to describe vehicle performance.

Module-II **(12 Hour)**

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis, Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

Module-III **(12 Hour)**

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

Module-IV **(06Hour)**

Matching the electric machine and the internal combustion engine (ICE) Communications, supporting subsystems, Introduction to energy management and their strategies used in hybrid and electric vehicle Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

Suggested reading

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric vehicle Technology Explained, Wiley 2003.

Course Outcomes

Students will be able to:

1. Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
2. Learn electric drive in vehicles /traction.

PEEE5413	Advanced Electric Drives	3-0-0	3 Credits

Course Objectives:

Students will be able to:

1. Understand advanced electrical drives and their analysis.
2. Learn Design of controller for drives.
3. Understand Scalar and Vector control of electrical drives.

MODULE-I (12 Hours)

Principles for vector and field-oriented control-Complex-valued dq-model of induction machines. Turns ratio and modified dq-models. Principles for field-oriented vector control of ac machines. Current controllers in stationary and synchronous coordinates. Rotor-flux oriented control of current-regulated induction machine.

MODULE-II (12 Hours)

Dynamic model of IM in rotor-flux coordinates. Indirect rotor-flux oriented control of IM - Direct rotor-flux oriented control of IM. - Methods to estimation of rotor-flux Generalized flux-vector control using current- and voltage decoupling networks. Generalized flux-vector oriented control. Current and voltage decoupling networks. Airgap-oriented control. Voltage-fed vector control. Stator-flux oriented vector control.

MODULE-III (12 Hours)

Principles for speed sensor-less control - Principles for speed sensor-less control. Sensor-less methods for scalar control. Sensor-less methods for vector control. Introduction to observer-based techniques. Direct torque control Induction Motor Drives. Self control synchronous motor drives. Introduction to speed control of switched reluctance machine. Control of Permanent magnet synchronous machine, Brushless dc Machine, Surface Permanent Magnet Machine and interior.

MODULE-IV (06 Hours)

Parameter sensitivity, selection of flux level, and field weakening – Parameter detuning in steady-state operation. Parameter detuning during dynamics. Selection of flux level. Control strategies for used in the over-speed region.

Text/References:

1. B. K. Bose, Modern Power Electronics and A.C. Drives, PHI, 2002.
2. G. K. Dubey, Power Semiconductor Controlled Drives, Prentice-Hall International1989.

Supplementary Reading:

1. G. K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2002.
2. W. Leonhard, Control of Electrical drives, Springer-Verlag, 1985.
3. P.C. Sen, Thyristor DC Drives, Wiley-Inter science Pub., Digitized on Dec, 2006.

Course Outcomes: Students will be able to:

1. Model and simulate electric drive systems
2. Design modulation strategies of power electronics converters, for drives application

3. Design appropriate current/voltage regulators for electric drives
4. Select and implement the drives for Industrial Process
5. Implement various variable speed drives in Electrical Energy Conversion System.

PEEE5414	Artificial Intelligence and Machine Learning	3-0-0	3 Credits

Course Objectives: This course will give students an overview of artificial intelligence principles and techniques in machine learning

Module I : [12 hours]

Biological foundations to intelligent Systems: Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, , Linear Models for Regression, Support Vector Machine, Kernel function and Kernel SVM.

Module II : [12 hours]

Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification Methods
Fuzzy Neural Networks and some algorithms to learn the parameters of the network like GA, System Identification using Fuzzy and Neural Network, Genetic algorithm, Reproduction, Crossover, Mutation, Introduction to evolutionary program.

Module-III: [12 hours]

Probability and Bayesian learning: Introduction, Bayes Theorem, Bayes theorem and concept Learning, maximum likelihood and least-squared error hypotheses, Bayes optimal classifier, Gibbs Algorithm, Naïve Bayes Classifier, example to illustrate Naïve Bayes classifier. Instance-Based Learning: Introduction, K-Nearest Neighbor Learning, Radial Basis Functions.

Module-IV: [6 hours]

Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model, the Curse of Dimensionality - Dimensionality Reduction - Factor analysis - Principal Component Analysis

TEXT BOOK

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.

References:

1. Simon Haykins, “Neural Networks”, Prentice Hall
2. Timothy Ross, “Fuzzy Logic with Engg. Applications”, McGraw Hill
3. Driankov, Dimitra, “An Introduction to Fuzzy Control”, Narosa Publication
4. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Com

Course Outcomes

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

1. Understand the application of Artifical intelligence in machine learning
2. Learn the concepts of biological foundations of artificial neural networks
3. Acquire the knowledge of Bayesian learning, Fuzzy Logic and GA