DEPARTMENT OF ELECTRICAL ENGINEERING

Scheme of Instruction
and
Syllabi of

M.E. (ELECTRICAL ENGINEERING)

Specialization of
POWER SYSTEMS
(Full Time & CEEP)

2023 - 2024

UNIVERSITY COLLEGE OF ENGINEERING

(AUTONOMOUS)

OSMANIA UNIVERSITY
HYDERABAD – 500 007, TELANGANA

UNIVERSITY COLLEGE OF ENGINEERING

Vision

The Vision of the Institute is to generate and disseminate knowledge through a harmonious blending of Science, Engineering and Technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate, disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services for the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programs
- Technology transfer and incubation

DEPARTMENT OF ELECTRICAL ENGINEERING

Vision

To strive for excellence in education and research; meet the requirement of industry in the field of electrical engineering to serve the nation.

Mission

- To provide knowledge-based technology and service to meet the needs of society in electrical and allied industries.
- To help in building national capabilities for excellent energy management and to explore non-conventional energy sources.
- To create research-oriented culture and to provide competent consultancy.
- To create and sustain environment of learning in which students acquire knowledge and learn to apply it professionally with due consideration of ethical and economic issues.
- To be accountable through self-evaluation and continuous improvement.

M.E. (Electrical Engineering)
Power Systems

Programme Educational Objectives

PEO1 To impart knowledge to cater the changing needs of electrical power systems.

PEO2 To prepare students for attaining latest technology in research and development in sustainable technologies related to Power Systems.

PEO3 To prepare students for successful career, capable of extending technical services to industry with proficiency in the field of power systems.

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 programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.

PO4 The student will develop an attitude to learn with self-motivation.

PO5 The student will be able to use simulation software to solve problems of real time power systems.

PO6 The student will be able to design, analyze and conduct experiments for practical power system networks.

SCHEME OF INSTRUCTION AND EVALUATION

M.E. - Power Systems

S. No.	Type of course	Course Code	Course Name	Contact hours per week		Scheme of Examination		Credits
				L	P	CIE	SEE	
	SEMESTER-I							
1	Core-I	**EE 3201**	Advanced Computer Methods in Power Systems	3	0	40	60	3
2	Core-II	**EE 3202**	Advanced Synchronous Machine Theory	3	0	40	60	3
3	Core-III	**EE 3203**	Distribution System Planning and Automation	3	0	40	60	3
4	Programme Elective - I	**EE 3211**	Advanced Power System Operation and Control	3	0	40	60	3
		EE 3112	Neural Networks and Fuzzy Logic					
		EE 3113	Renewable Energy Sources					
		EE 3114	Power Electronic Applications to Power Systems					
5	Programme Elective - II	**EE 3121**	Reliability Engineering	3	0	40	60	3
		EE 3221	Power Quality Engineering					
		EE 3302	Power Electronic Converters for Renewable Energy					
6	Programme Elective - III	**EE 3231**	Power System Deregulation	3	0	40	60	3
		EE 3132	Advanced Microprocessors					
		EE 3133	Programmable Logic Controllers					

		EE 3134	Digital Signal Processing					
		EE 3135	Python Programming					
7	Laboratory - I	**EE 3251**	Power Systems Laboratory - I	0	3	50	-	1.5
8	Seminar - I	**EE 3261**	Seminar - I	0	3	50	-	1.5
	TOTAL			**18**	**6**	**390**	**360**	**21**
	SEMESTER-II							
1	Core-IV	**EE 3204**	Power System Stability	3	-	40	60	3
2	Core-V	**EE 3205**	Advanced Power System Protection	3	-	40	60	3
3	Core-VI	**EE 3206**	Real Time Applications in Power Systems	3	-	40	60	3
4	Programme Elective-IV	**EE 3141**	Modern Control Theory	3	-	40	60	3
		EE 3142	Smart Grid Technologies					
		EE 3143	Grid Integration of Distributed Generation					
		EE 3241	Reactive Power Control and Voltage Stability					
5	Programme Elective-V	**EE 3124**	Hybrid Electric Vehicles	3	-	40	60	3
		EE 3152	Digital Circuits & Logic Design					
		EE 3122	Optimization Methods					
		EE 3251	Sub Station Design and Automation					
6	Open Elective	**OE 901 EE**	*Waste to Energy	3	-	40	60	3
		OE 902 EE	*Power Plant Control and Instrumentation					
		OE 941 CS	Business Analytics					
		OE 942 ME	Industrial Safety					
		OE 943 ME	Operations Research					

		OE 944 CE	Cost Management of Engineering Projects					
		OE 945 ME	Composite Materials					
		OE 941 BM	Medical Assistive Devices					
		OE 942 BM	Medical Imaging Techniques					
		OE 941 LA	Intellectual Property Rights					
7	Mini Project	**EE 271**	Mini Project	-	4	50		2
8	Laboratory - II	**EE 252**	Power Systems Laboratory - II	-	3	50	-	1.5
9	Laboratory - III	**EE 253**	Power Systems Laboratory - III	-	3	50	-	1.5
	TOTAL			**18**	**10**	**390**	**360**	**23**
	SEMESTER-III							
1	Audit Course – I (Online)	**AC2001 EE**	Engineering Research Methodology in Electrical Engineering	2	-	40	60	0
2	Audit Course – II (Online)	**AC101EG**	English for Research Paper Writing	2	-	40	60	0
		AC102	Disaster Mitigation & Management					
		AC103	Sanskrit for Technical Knowledge					
		AC104	Value Education					
		AC035	Stress Management by Yoga					
		AC036	Personality Development Through Life Enlightenment Skills					
		AC037	Constitution of India					
		AC038	Pedagogy Studies					
3	Major Project Phase – I Dissertation	**EE281**		-	20*	100		10
	TOTAL			**4**	**20**	**180**	**120**	**10**
	SEMESTER-IV							
1	Major Project Phase – II Dissertation	**EE282**		-	32*	100	100	16
	TOTAL			**40**	**64**	**1010**	**940**	**70**

Note:

- Dissertation-II has two parts, CIE - I and CIE - II, at the end of 8" week and 16th week respectively for evaluation of 50 marks each.
- Audit Courses will be offered in ONLINE mode and SEE will be conducted in
- Computer Based Test Mode.
- Research Methodology and IPR will be offered as an Audit Course for all PG Programs.
- Engineering Research Methodology Workshop will be conducted for one week for Ph.D. scholars.
- Six Core subjects, Five Programme Electives, One Open Elective, Three Laboratory Courses, One Mini project, and One Seminar should normally be completed by the end of semester II.
- Two Audit Courses and Dissertation - I should be completed by the end of semester III.

***The student has to work a minimum of 20 hours/week and 32 hours/week at Dissertation - I and II.**

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L – No. of Lecture Contact hours / Week P – No. of Practical Contact hours /Week
CIE – Continuous Internal Evaluation SEE – Semester End Evaluation

EE 3201
ADVANCED COMPUTER METHODS IN POWER SYSTEMS

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand various incidence matrices and formulation of network matrices.
- To be familiar with various methods of triangularization and significance of optimal ordering.
- To familiarize with bus impedance matrix preparation for a given network.
- To understand load flow techniques and solution methods.
- To familiarize short circuit studies and its importance.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Able to obtain network matrices using graph theory.
2. Utilize optimal ordering and Factorization for efficient computations
3. Build ZBUS for single phase and three phase networks
4. Choose a suitable load flow technique for a particular application.
5. Analyze various types of faults.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	2
CO2	3	-	3	-	-	2
CO3	3	-	3	-	-	2
CO4	3	-	3	-	-	2
CO5	3	-	3	-	-	2

UNIT I

Graph Theory: Network graph – Incidence matrices – Element node incidence matrix – Bus incidence matrix –Branch path incidence matrix – Basic and Augmented cut set incidence matrices – Basic and augmented branch incidence matrices – Basic and Augmented loop incidence matrices – Primitive network – Formation of Y Bus, YBR & Z loop by singular transformation.

UNIT II

Z Bus formation: Matrix representation of power systems, Triangularization, Gaussian elimination method, LU, LDU factorization, Table of factors, Optimal ordering. Algorithm for formation of Z Bus matrix. Concept of branch and link addition – modification of bus impedance matrix for changes in the network, Z bus – sparse vector method.

UNIT III

Load flow studies: Concepts of load flow – classification of buses, Representation of fixed tap setting and on load tap changing transformers, Power System Loads-Basic Load Modeling concepts, Modeling of induction and synchronous motors**.** Load flow solution using Gauss-Seidel, Newton-Raphson methods – Treatment of voltage-controlled buses – Acceleration factors, Decoupled and Fast decoupled method, Flow chart and comparison of different methods.

UNIT IV

Modifications in Z bus matrix: Representation and performance equation of 3phase network elements – Three phase network elements with balanced and unbalanced excitation – Transformation matrices –Symmetrical and Clarke's components – Algorithm for formation of three phase bus impedance matrix –Modification of three phase Z bus changes in network.

UNIT V

Short circuit studies: Basic assumption in short circuit studies – System representation – General equations for short circuit study in phase variables and Symmetrical components for fault current and node voltage – Short circuit calculations for balanced three phase network using Z bus – Fault impedance and admittance matrices – Analysis of 3 phase, line to ground and double line to ground faults – Flow chart for short circuit study. Short circuit studies using Table of Factors

References

1. Stagg & El-Abiad. *Computer methods in Power System Analysis*, Tata McGraw Hill, 1968.
2. Kusic George L, *Computer Aided Power System Analysis*, - Prentice Hall, 1986.
3. M.A.Pai ,*Computer techniques in Power System Analysis*, Tata McGraw Hill, 2006.
4. Prabha Kundur, *Power System Stability & Control,* Tata McGraw Hill edition, 2006.

EE3202

ADVANCED SYNCHRONOUS MACHINE THEORY

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- Utilize the reference frame theory to model, analyze, and design AC machine drives, and understand advanced electromechanical systems
- Carry out DC machines and drives modelling and dynamic performance analysis, and conduct DC machine drive designs and design optimization
- Understand and use induction machine transformation theory for modelling, analysis, and design of high-performance induction machine drives
- Understand and use synchronous machine transformation theory for modelling, analysis, and design of high-performance synchronous machine drives
- Observe, measure, and record dynamic performance of DC and AC machines and their drives

Course Outcomes

After the completion of this course, students will be able to:

1. Utilize the reference frame theory to develop the mathematical model for a synchronous machine to use in stability computations and to developed State space formation of synchronous machine equations a) using current as state variable and b) using flux linkages as state variable.
2. Understand and use synchronous machine phasor diagram models from the initial conditions and available data;
3. Understand and use linear models and simplified models of synchronous machine and representation in state space model,
4. Understand and use synchronous machine excitation system models and
5. Development of State space formation of excitation systems of synchronous machine

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	2
CO2	3	-	3	-	-	2
CO3	3	-	3	-	-	2
CO4	3	-	3	-	-	2
CO5	3	-	3	-	-	2

UNIT I

The Synchronous machine - Park's transformation – Flux linkage equations – Voltage equations - Formulation of state space equations- Current formulation – Per-unit conversion – Normalizing voltage and torque equations – Torque and power – Equivalent circuits of synchronous machine – Flux linkage state space model – Treatment of saturation Synchronous machine connected to infinite bus – Current, Voltage and flux linkage models.

UNIT II

Sub-transient and transient reactances and time constants – Simplified models of the synchronous machine – Steady state equations and phasor diagrams – Machine connected to infinite bus with local load at machine terminals – Determining steady state conditions.

UNIT III

Linear models of the synchronous machine – Linearization of the generator state space current, voltage and flux linkage models.

UNIT IV

Linearization of the load equation for the one machine problem –Simplified linear models – Effect of loading – State space representation of simplified model.

UNIT V

Representation of excitation systems, Different models of excitation systems – IEEE, 1, 2 & 3 systems – Representation of loads. State-space representation of the excitation system-simplified linear model, complete linear model.

References

1. P.M.Anderson&A.A.Foud, *Power System Control & Stability,* Iowa State University Press, U.S.A. (1977), reprint 2005.
2. Kimbark, E.W., *Power System Stability,* Vol. III, Dover, New York, 1968.
3. Yao-Nan-Yu, *Power System Dynamics, Academic Press,* 1983.

EE 3203

DISTRIBUTION SYSTEM PLANNING AND AUTOMATION

(Core - III)

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To study and Analyze about distribution systems planning based on future data.
- Understand concept of sub transmission and substation design.
- To learn design of distribution network Primary system.
- To calculate the electrical parameters and economical cost of secondary distribution network.
- Introduce to distribution automation, SCADA, components and their functions.

Course Outcomes

After the completion of this course, students will be able to:

1. Analyze and Design of distribution system planning and characteristics of distribution systems.
2. Identify and select appropriate sub–station location and design of sub transmission system.
3. Design and analyze the primary distribution system based on load demand.
4. Evaluate voltage, power losses and economical cost of secondary distribution network
5. Be familiar with control functions of Distribution Automation, Consumer Information Service, Geographical Information System and Automatic Meter Reading.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	2
CO2	3	-	3	-	-	2
CO3	3	-	3	-	-	2
CO4	3	-	3	-	-	2
CO5	3	-	3	-	-	2

UNIT I

Distribution System Planning: Introduction, Distribution system Planning: Factors effecting planning, Present techniques, planning models, Planning in the future, Future nature of distribution planning, Role of computer in Distribution planning. Load characteristics and Load models – Wye connected loads, Delta connected loads.

UNIT II

Sub Transmission lines and Substations: Types of sub – transmission, Distribution substation, bus schemes, substation location, rating of substation, calculation of voltage drops with primary feeders, Derivation of the K constant, Interpretation of the Percentage Voltage drop formula.

UNIT III

Primary Feeders: Types of primary feeders, Primary feeder loading, Tie-lines, Distribution feeder exit – rectangular and radial type development, Design of radial primary feeders – Voltage drop calculations by A,B,C,D constants, Uniformly distributed load, Non uniformly distributed load. Distribution Feeder Analysis – the ladder Iterative technique.

UNIT IV

Secondary Feeders: Secondary voltage levels, present design practice, Secondary Banking, Economic design of secondaries, Total annual cost equation, Voltage drop and Power loss calculations. Distribution system voltage regulation: Quality of services, voltage control, Application of capacitors in Distribution system.

UNIT V

Distribution Automation: Distribution Automation, Project planning, Definitions, Communication, Sensors, Supervisory Control and Data Acquisition Systems (SCADA), Consumer Information Service (CIS), Geographical Information System (GIS), Automatic Meter Reading (AMR), Automation system.

References

1. TuranGonen, Electric Power Distribution System Engineering, CRC Press, Second Edition 2007
2. WilliamKersting, Distribution Modelling & Analysis – CRC Press – third edition - 2002
3. A.S. Pabla, Electric Power Distribution, Tata McGraw Hill, Fifth Edition, 2005.

EE3211

ADVANCED POWER SYSTEM OPERATION AND CONTROL

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the economics of power system operation using thermal units.
- To analyze the economics of hydro-thermal units.
- To become familiar with multi area load frequency control and application of optimal control to LFC.
- To gain knowledge of the approaches used for load forecasting techniques.

Course Outcomes

After the completion of this course, students will be able to:

1. Develop generation dispatching schemes for thermal units, shared generators and scheduling between areas.
2. Develop economic generating schedules for combined hydro-thermal units using dynamic programming method.
3. Analyze load frequency control of multi area system, study effects of various components on LFC
4. Understand optimal load frequency control of multi area system.
5. Analyze various methods of Load Forecasting.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	3	-	3	-	-	3
CO3	3	-	3	-	-	3
CO4	3	-	3	-	-	3
CO5	3	-	3	-	-	3

UNIT I

***Generation Base Power Setting*:** Economic dispatch of generation with line losses - Classical method to calculate loss coefficients – Loss coefficients calculation using Y bus and sparse matrix techniques Execution of the economic dispatch utilizing the load flow Jacobian and economic dispatch – Economic dispatch using shared generators – Economic exchange of power between areas.

UNIT II

Combined Operation of Hydro-Thermal Plants: Dynamic programming method – Kirchmayer's method of co-ordination equations - Decomposition technique for Hydro–thermal schedules.

UNIT III

ALFC of Multi-Control Area System (Pool Operation): The two Area system . Block diagram representation of a two Area system .Static and dynamic response of a two Area system .Tie-line bias control for two Area and multi area systems .Steady state instabilities .Negative damping .Effect of change of E' Factors causing changesin E'. Inclusion of AVR loop.

UNIT IV

AGC using Kalman methods: Dynamic model in state variable form, Application of optimal control to LFC – Optimal control index - Optimal control trajectories – Application of optimal control to Two Area system for LFC.

UNIT V

Load Forecasting Technique: Methodology –Estimation of average and trend terms– Estimation of periodic components–Estimation of y(k): Time series approach- Estimation of stochastic component: Kalman filters approach–Long term load predictions– Reactive load forecast.

References

1. Kusic George L - Computer Aided Power System Analysis,- Prentice Hall, 1986.
2. P.S.R. Murty, Power System Operation and Control - Tata McGraw Hill, 1984.
3. OlleLElgerd, Electric Energy System Theory - Tata McGraw Hill, 1982.
4. D.P. Kothari, l.J.Nagrath, Modern Power System Analysis, Tata McGraw Hill, 3Edition, 2004.

EE3112

NEURAL NETWORKS AND FUZZY LOGIC

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To introduce the Neural & fuzzy intelligence
- To study the different models in ANN and their applications
- To familiarize different learning concepts and algorithms of Neural Networks
- To familiarize the fundamentals of Fuzzy Logic required to apply Fuzzy Logic in control, pattern recognition and Planning and Diagnosis.
- T0 give exposure to Neural Network and Fuzzy Logic applications in Electrical Engineering

Course Outcomes

After the completion of this course, the students shall be able to:

1. Explain the basic concepts in Fuzzy and Neural intelligence.
2. Understand the different Neural network models
3. Understand different learning methods and algorithms of Neural Networks.
4. Apply the fuzzy concepts in the areas of control, pattern recognition and Planning and Diagnosis
5. Apply the knowledge Neural Networks and Fuzzy Logic to different power systems problems.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	2	3
CO2	3	-	3	-	2	3
CO3	3	-	3	-	2	3
CO4	3	-	3	-	2	3
CO5	3	-	3	-	2	3

UNIT I

Neural and Fuzzy Intelligence: Fuzziness as multi-valence - Bivalent paradoxes as fuzzy midpoints - Sets as points in cubes - Subset hood and probability- The dynamical system approach to machine intelligence - Brain as a dynamical system - Neural networks as trainable dynamical system - Intelligent behaviour as adaptive
model free estimation - Generalization and creativity - Learning as change- Rules vs.principles - Symbolic vs. numeric processing - Structured numerical estimators.

UNIT II

Neural Network Theory: Neurons as functions - Signal monotonicity Biological activities and signals - Neuron fields - Neuronal dynamic systems - Common signal functions - Pulse coded signal functions- Additional neuron dynamics – Additive neural feedback - Additive activation models - Bivalent BAM theorem - Hopfield
model.

UNIT III

Synaptic Dynamics: Unsupervised learning - Learning laws - Probability spaces and random processes - Signal Hebbian learning- Competitive learning – Differential Hebbian learning - Supervised learning - The perceptions - LMS algorithm – Back propagation algorithm - AVQ algorithm - Global stability of feedback neural
networks.

UNIT IV

Fuzzy Logic: Fuzzy sets and systems - Geometry of fuzzy sets - Fuzzy entropy theorem- Entropy subset - Hood theorem - Fuzzy and neural function estimators - FAM system architecture - Uncertainty and estimation - Types of uncertainty - Measure of fuzziness - Classical measures of uncertainty – Measures of dissonance - Confusion and non-specificity. Fuzzy logic structure - Knowledge base defuzzification - Fuzzy logic in control - Pattern recognition - Planning and Diagnosis.

UNIT V

Fuzzy Logic and ANN Application: Application to load forecasting - Load flow, Fault detection and Unit commitments - LF control - Economic dispatch.

References

1. Bart Kusko, *Neural Networks and Fuzzy System* - Prentice Hall of India, 1994.
2. B.Yegnanarayana, *Artificial Neural Networks*,PHI Learning,1994.

EE3113

RENEWABLE ENERGY SOURCES

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the concepts and Importance of renewable energy sources such as solar, wind, biomass, tidal power.
- To make the students understand the advantages and disadvantages of different renewable energy sources
- To be familiar with the technologies used to generate electrical energy, storage and applications

Course Outcomes

After the completion of this course, the students will be able to:

1. Understand the basic principle of operations of renewable energy sources.
2. Understand the applications of renewable energy sources.
3. Understand the technology processes of renewable energy sources.
4. Understand the technology processes of renewable energy sources
5. Study of the applications of renewable energy sources

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	3	2
CO2	3	-	3	-	3	2
CO3	3	-	3	-	3	2
CO4	3	-	3	-	3	2
CO5	3	-	3	-	3	2

Syllabus Contents

UNIT I

Review of Conventional and Non-Conventional energy sources - Need for nonconventional energy sources Types of Non- conventional energy sources – Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems – Ion exchange membrane cell – Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells — Polarization - Conversion efficiency and Applications of Fuel Cells.

UNIT II

Solar energy - Solar radiation and its measurements - Solar Energy collectors –Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

UNIT III

Wind energy- Principles of wind energy conversion systems - Nature of wind – Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations -Advantages and disadvantages of WECS -Wind energy collectors – Wind electric generating and control systems - Applications of Wind energy Environmental aspects.

UNIT IV

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-thermal Energy - Types of Geo-thermal Energy Systems - Applications of Geo-thermal Energy.

UNIT V

Energy from Biomass - Biomass conversion technologies / processes – Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass - Biomass gasifiers.

References

1. Rai G.D, *Non-Conventional Sources of Energy,* Khandala Publishers, New Delhi, 1999.
2. M.M.El-Wakil, *Power Plant Technology.* McGraw Hill, 1984.

EE3114

POWER ELECTRONIC APPLICATIONS TO POWER SYSTEMS

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the issues involved in existing Power Transmission system
- To be familiar with the Techniques to overcome the problems associated with AC Power Transmission system
- To Understand the control of active and reactive power control using Power electronic converters

Course Outcomes

After the completion of this course, the students shall be able to:

1. Know the application of FACTS devices in Power Transmission system.
2. Study and apply the power transmission schemes – HVDC Transmission
3. Implement the control circuits based on the Controlling parameters of HVDC system
4. Select appropriate FACTS controllers depending on application.
5. Understand various types of HVDC systems and their advantages.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	3	-	3	-	-	3
CO3	3	-	3	-	-	3
CO4	3	-	3	-	-	3
CO5	3	-	3	-	-	3

UNIT I

***Facts concepts*:** Reactive power control in electrical power transmission, principles of conventional reactive power compensators. Introduction to FACTS, flow of power in AC parallel paths, meshed systems, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers.

UNIT II

Static shunt and series compensators: Shunt compensation - objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators - SVC, STATCOM, SVC and STATCOM comparison. Series compensation - objectives of series compensation, thyristor switched series capacitors (TCSC), static series synchronous compensator (SSSC), power angle characteristics, and basic operating control schemes.

UNIT III

Combined compensators: Unified power flow controller (UPFC) - Introduction, operating principle, independent real and reactive power flow controller and control structure. Interline power flow controller (IPFC), Introduction to Active power filtering, Concepts relating to Reactive power compensation and harmonic current compensation using Active power filters.

UNIT IV

HVDC transmission: HVDC Transmission system: Introduction, comparison of AC and DC systems, applications of DC transmission, types of DC links, Layout of HVDC Converter station and various equipment. HVDC Converters, analysis of bridge converters with and without overlap, inverter operation, equivalent circuitrepresentation of rectifier and inverter configurations.

UNIT V

Control of HVDC System: Principles of control, desired features of control, converter control characteristics, power reversal, Ignition angle control, current and extinction angle control. Harmonics-introduction, generation, ac filters and dc filters. Introduction to multiterminal DC systems and applications, comparison of series and parallel MTDC systems.

References

1. Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.
2. Hingorani,L.Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', IEEE Press New York, 2000 ISBN –078033 4588.
3. Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., 2010.
4. Mohan Mathur R. and Rajiv K.Varma , 'Thyristor - based FACTS controllers for Electrical transmission systems', IEEE press, Wiley Inter science , 2002.
5. Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1st Edition, 2007.
6. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar AngelesCamacho 'FACTS –Modeling and simulation in Power Networks' John Wiley & Sons, 2002.

EE 3121

RELIABILITY ENGINEERING

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To comprehend the basics of probability distributions & reliability models.
- To model systems with series-parallel block diagrams and state-space diagrams and to understand time dependent and limiting state probabilities using Markov models.
- To understand multi-mode failures of electrical & electronic circuits and their effect on reliability & availability.
- To understand reliability & availability models for generation, transmission and distribution systems and evaluate critical indices.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Able to relate the probability concepts and distributions in reliability engineering studies
2. Able to draw reliability logic diagram and state-space diagram of engineering systems to evaluate reliability and availability
3. Apply multi-mode failures in electrical and electronic circuits
4. Model generation and transmission systems for reliability studies.
5. Evaluate various reliability indices related to generation, transmission and distribution systems

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	1
CO2	3	-	3	-	-	1
CO3	3	-	3	-	-	1
CO4	3	-	3	-	-	1
CO5	3	-	3	-	-	1

Syllabus Contents

UNIT I

Discrete & Continuous random variables – Binomial, Exponential &Weibull distributions – Causes of failure – Failure rate & Failure density – Bath tub curve – Reliability & MTTF – Maintainability & Availability – MTBF & MTTR – Reliability block diagram – Series & Parallel systems – Conditional probability - Minimal Cutset
& Tie-set methods

UNIT II

Continuous Markov models – State space diagram - Reliability models of single unit, two unit & standby systems – Reliability & Availability models with repair – Frequency of failures – State transition matrix and estimation of MTTF.

UNIT III

Multi-mode failures - Short circuit & open circuit failures - Resistors & capacitors in series & parallel - Diodes & MOSFETs in series & parallel - Quad system - Reliability Prediction - MIL standards - Parts count technique - Parts stress technique - Reliability, Availability and MTTF evaluation of Power electronic circuits & Drive Systems

UNIT IV

Outage definitions – Markov model of Generating plant with identical and non-identical units – Capacity Outage probability table – Cumulative frequency – LOLE & LOEE – Composite Generation & Transmission systems - Radial configuration – Conditional probability approach

UNIT V

Customer oriented, load oriented & energy oriented indices of distribution system – Application to radial systems – Effects of lateral distributer protection, disconnects, protection failures & transferring loads – Parallel & Mesh networks – Dual transformer feeder – Approximate, Network reduction & FMEA methods

References

1. Roy Billinton, R.N. Allan, ‘Reliability Evaluation of Engineering Systems’, Springer International Edition, Plenum Press, New York, 1992
2. E. Balaguruswamy, ‘Reliability Engineering’, Tata McGraw Hill Education Pvt. Ltd., 2012
3. Charles E. Ebeling, ‘An Introduction to Reliability and Maintainability Engineering’, McGraw Hill International Edition, 1997
4. L. Umanand, ‘Power Electronics: Essentials & Applications’, Wiley, 2009
5. Roy Billinton, R.N. Allan, ‘Reliability Evaluation of Power Systems’, Springer, 1st Edition, Plenum Press, New York, 1996.

EE3221

POWER QUALITY ENGINEERING

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- The importance of power quality, different power quality issues and their effects in power system network.
- Different Methods of calculating the voltage sag magnitude and duration
- Understand the types of sags and characterize the voltage sags experienced by machines
- Know harmonics, locate sources of harmonics and mitigate harmonics
- Fundamental understanding of measuring equipment and assessment of PQ measuring data

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand the significance of power quality study and identify various power quality disturbances.
2. Write algorithms to calculate voltage sags magnitude and duration in power system.
3. Demonstrate the effect and analyze the characteristics of voltage sags experienced by ASDs.
4. Evaluate THD and mitigate harmonics in distribution system
5. Operate and use PQ measuring equipment for assessment of data

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	2	3
CO2	3	-	3	-	2	3
CO3	3	-	3	-	2	3
CO4	3	-	3	-	2	3
CO5	3	-	3	-	2	3

UNIT I

Introduction: Power Quality (PQ), PQ problems, Sags, Swells, Transients, Harmonics, Interruptions, Flicker, Voltage fluctuations, Notch, Transient Overvoltages – Sources of Transient Over voltages. Wiring and Grounding: Resources, Definitions, Reasons for Grounding, Typical wiring and grounding problems, Solutions to wiring and grounding problems.

UNIT II

Voltage Sag Analysis: Voltage sag characteristics - Methodology for computation of voltage sag magnitude and occurrence, Accuracy of sag analysis, Duration & frequency of sags, Faults behind transformers, Effect of pre-fault voltage, Simple examples, Voltage dip problems, fast assessment methods for voltage sags in distribution systems.

UNIT III

PQ Consideration in Industrial Power Systems: Adjustable speed drive (ASD) systems and applications, Sources of power system harmonics, Mitigation of harmonics, Characterization of voltage sags experienced by three-phase ASD systems, Types of sags and phase angle jumps, Effects of momentary voltage dips on the operation of induction and synchronous motors.

UNIT IV

Harmonics: Harmonic distortion, Voltage versus current distortion, Harmonics versus Transients, Harmonic Indices, Harmonic sources from commercial loads, Harmonic sources from industrial loads, Locating Harmonic sources, System response characteristics, Effects of Harmonic distortion, inter harmonics, Devices for controlling harmonic distortion.

UNIT V

Power quality monitoring: Monitoring considerations, Historical Perspective of PQ Measuring Instruments, PQ measurement equipment, Assessment of PQ measurement data, Application of intelligent systems, PQ monitoring standards.

References

1. Math H.J. Bollen, *Understanding Power Quality Problems*, IEEE Press, 1999.
2. Roger C. Dugan, Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty, *Electrical Power Systems Quality,* Second Edition, Tata McGraw-Hill Edition.
3. C. Sankaran, *Power Quality*, CRC Press, 2002.

EE3302

POWER ELECTRONIC CONVERTERS FOR RENEWABLE ENERGY

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To learn the types of renewable sources such as Wind, solar, hydro and geothermal sources.
- To understand the principle and operation of various DC-DC converters.
- To understand the concepts of grid connected inverters and grid connected issues.
- To understand the principle of operation of doubly fed induction generator with rotor side converter topologies.

Course Outcomes

After the completion of this course, students will be able to:

1. Understand P-V & I-V characteristics of solar PV and different MPPT Techniques.
2. Understands the maximum power point tracking for different Converters.
3. Analyze the grid connection issues and different types of transformer less topologies.
4. Understand the P-V and I-V characteristics and power extraction of wind energy systems.
5. Analyze the different types of wind generators for wind power applications.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	3	2
CO2	3	-	3	2	3	2
CO3	3	-	3	2	3	2
CO4	3	-	3	2	3	2
CO5	3	-	3	2	3	2

Syllabus Contents

UNIT I

Introduction to renewable sources: world energy scenario, Wind, solar, hydro, geothermal, availability and power extraction. Introduction to solar energy: Photovoltaic effect, basics of power generation, P-V &IV characteristics, effect of insolation, temperature, diurnal variation, shading, Modules, connections, ratings, Power extraction (MPP) tracking and MPPT schemes; standalone systems, grid interface, storage, AC-DC loads.

UNIT II

DC-DC converters for solar PV: buck/boost/buck-boost /flyback /forward/cuk, bidirectional converters, Interleaved and multi-input converters.

UNIT III

Grid connected Inverters: 1ph, 3ph inverters with & without transformers, Heric, H6, Multilevel Neutral point clamp, Modular multilevel, CSI; Control schemes: unipolar, bipolar, PLL and synchronization, power balancing / bypass, Parallel power processing; Grid connection issues: leakage current, Islanding, harmonics, active/reactive power feeding, unbalance.

UNIT IV

Introduction to wind energy: P-V, I-V characteristic, wind power system: turbine generator-inverter, mechanical control, ratings; Power extraction (MPP) and MPPT schemes. Generators for wind: DC generator with DC to AC converters; Induction generator with & w/o converter.

UNIT V

Synchronous generator with back to back controlled/ uncontrolled converter; Doubly fed induction generator with rotor side converter topologies; permanent magnet based generators. Battery: Types, charging discharging. Introduction to AC and DC micro grids.

References

1. SudiptaChakraborty, Marcelo G. Simes, and William E. Kramer. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration. Springer Science & Business, 2013.
2. Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems,CRC Press,2013.
3. Chetan Singh Solanki, Solar Photovoltaics: fundamentals, Technologies and Applications, Prentice Hall of India, 2011.
4. N. Mohan, T.M. Undeland& W.P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989
5. Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2004
6. E. Guba, P. Sanchis, A. Ursa, J. Lpez, and L. Marroyo, Ground currents in singlephasetransformerless photovoltaic systems, Progress in Photovoltaics: Research and Applications, vol. 15, no. 7, 2007.
7. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011.
8. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, WileyIEEE Press,2011.

EE3231

POWER SYSTEM DEREGULATION

Instruction: 3periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- Understand the new dimensions associated with operation of deregulated power systems.
- Introduction to the power sector market, trading and bidding strategies.
- Apply the concept of deregulation and ATC.
- Understand the electricity power business and technical issues in a deregulated power system in both Indian and world scenario.
- To learn different pricing mechanisms and power trading in deregulated power systems.

Course Outcomes

After the completion of this course, students will be able to:

1. Understand the developments in the process of deregulation worldwide.
2. Identify the roles and responsibilities of different entities in power market.
3. Calculate Available Transmission Capability using various methodologies.
4. Explore issues like congestion management, Transmission pricing, Ancillary Services Management.
5. Apply the concepts and terminologies used in power pools and transaction issues.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	3	-	3	-	-	3
CO3	3	-	3	-	-	3
CO4	3	-	3	-	-	3
CO5	3	-	3	-	-	3

UNIT I

Overview of Key Issues in Electric Utilities: Introduction – Restructuring models – Independent system operator (ISO) – Power Exchange - Market operations – Market Power – Stranded costs – Transmission Pricing – Congestion Pricing.

UNIT II

OASIS: Open Access Same-Time Information System**:** Structure of OASIS –Posting of Information – Transfer capability on OASIS – Definitions Transfer Capability Issues – ATC – TTC – TRM – CBM calculations – Methodologies to calculate ATC, Biding strategies.

UNIT III

Electricity Pricing: Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves –Short-term Price Forecasting.

UNIT IV

Power system operation in a competitive environment**:** Introduction – Operational Planning Activities of ISO- the ISO in Pool Markets – The ISO in Bilateral Markets – Operational Planning Activities of a Genco, Congestion management.

UNIT V

Ancillary Services Management: Introduction – Reactive Power as an Ancillary Service – a review – Synchronous Generators as Ancillary Service Providers.

References

1. Kankar Bhattacharya, Math H.J. Bollen, Jaap E.Daalder, 'Operation of Restructured Power System' Kluwer Academic Publisher – 2001
2. Mohammad Shahidehpour, and Muwaffaq alomoush, - "Restructured Electrical Power systems" Marcel Dekker, Inc. 2001
3. Loi Lei Lai; "Power system Restructuring and Deregulation", John Wiley & Sons Ltd., England.

EE 3132

ADVANCED MICROPROCESSORS

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the interfacing circuits for various peripheral applications
- To illustrate the architecture of processor of 8086
- To introduce to the programming and interfacing techniques of 8086
- Apply knowledge of soft skill and other resources to design automated system with programming module
- To introduce the architecture of advanced data processor

Course Outcomes

After the completion of this course, the students shall be able to:

1. Design interfacing circuits of various devices with the microprocessor
2. Outline the architecture of 8086 processor
3. Develop programming skills in assembly language.
4. Understand the impact of microprocessor-based system in process of automation.
5. Be familiar with the architecture and operation of processor

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	2
CO2	3	-	3	-	-	2
CO3	3	-	3	-	-	2
CO4	3	-	3	-	-	2
CO5	3	-	3	-	-	2

Syllabus Contents

UNIT I

Review of Basic I/O Interfaces: Programmable Interval Timer 8253 – Programmable peripheral Interlace 8255 – Programmable Interrupt Controller 8259 Microprocessor 8085 applications.

UNIT II

8086 Architecture: CPU Architecture Machine language instructions – Instruction execution – Timing.

UNIT III

Assembler Language Programming: Incorporating Data Transfer –Branch Arithmetic - Loop -NOP and HLT - Flag manipulation, Logical Shift and Rotate Instructions – Directives and Operators.

UNIT IV

Modular Programming: Linking and Relocation –Stacks – Procedures – Interrupts and Interrupt Routines. Byte and String Manipulation: String instruction – REP Prefix –Text Editor – Table translation.

UNIT V

8087 Numeric Data Processor: NDP –Data types –Processor architecture –Instruction set.

References

1. Liu, Gibson, Microcomputer Systems The 8086/8088 Family, Prentice Hall India, 1986.
2. Ghosh, Sridhar, 0000-8085 introduction to Microprocessors, Prentice HallIndia, 1991.

EE3134

DIGITAL SIGNAL PROCESSING

Instruction: 3periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- *To gain knowledge about discrete time signal and systems; their representation, operations and properties.*
- *To understand the importance of frequency domain representation of discrete time signals and calculating DTFT, DFT and FFT.*
- *To learn to represent discrete time signals and systems in Z-domain and finding solution of difference equations using z-transform.*
- *To design IIR and FIR filters.*
- *To familiarize with the digital signal processor TMS320C5X*

Course Outcomes

After the completion of this course, the students shall be able to:

1. *Produce discrete time signals and analyze them and determine discrete time system output for the given discrete time input signals.*
2. *Determine frequency domain representation DTFT, DFT and FFT.*
3. *Use z-transforms effectively in the analysis and solutions of discrete time systems.*
4. *Design IIR and FIR filters.*
5. *Explain the architecture, memory and peripherals of Digital Signal Processor.*

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	-	-	-
CO2	2	-	2	-	-	-
CO3	2	-	2	-	-	-
CO4	2	-	2	-	-	-
CO5	2	-	2	-	-	-

Syllabus Contents

UNIT I

Introduction to Digital Signal Processing: Discrete time signals & sequences - Linear shift Invariant systems - Stability and causality- Linear constant coefficient difference equations - Frequency domain representation of discrete time signals and systems.

UNIT II

Discrete Fourier Series: Properties of Discrete Fourier Series - DFS representation of periodic sequences - Discrete Fourier Transforms- Properties of DFT – Linear convolution of sequences using DFT - Computation of DFT - Fast Fourier Transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms inverse FFT.

UNIT III

Applications of Z-Transforms: Solution of difference equations of digital filters - System function - Stability criterion - Frequency response of stable systems - Realization of digital filters - Direct, Canonic, Cascade & Parallel forms.

UNIT IV

IIR Digital Filters: Analog filter approximations - Butterworth and Chebyshev - Design of IIR Digital filters from analog filters - Bilinear transformation method - Step & Impulse invariance techniques - Spectral Transformations. FIR Digital Filters: Characteristics of FIR Digital Filters - Frequency response - Design of FIR filters using Window Techniques.

UNIT V

Introduction to digital signal processors: TMS320C5X architecture – CALU, ARAU, PLU, MMR, on chip memory, on chip peripherals, Digital signal processing applications.

References

1. Proakis & Manolakis, Digital Signal Processing Principles, P Pub. 1994.
2. Sahivahanam, Valtavaraj & Gnanapariya, Digital Sign Processing, TMGH Pub. 2001.
3. Oppenheim & Sehaffter, Digital Signal Processing, PHI Pub.
4. S.K.Mitra, Digital Signal Processing, TMH, 1996.

EE3135

PYTHON PROGRAMMING

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.

Course Outcomes

After the completion of this course, the students shall be able to:

- Develop algorithmic solutions to simple computational problems.
- Develop and execute simple Python programs.
- Develop simple Python programs for solving problems.
- Structure a Python program into functions.
- Represent compound data using Python lists, tuples, and dictionaries.
- Read and write data from/to files in Python Programs

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	-	-	-
CO2	2	-	2	-	-	-
CO3	2	-	2	-	-	-
CO4	2	-	2	-	-	-
CO5	2	-	2	-	-	-

Syllabus Contents

UNIT I

Introduction to Python Programming: Python Interpreter and Interactive Mode-Variables and Identifiers — Arithmetic Operators — Values and Types — Statements, Reading Input, Print Output, Type Conversions, The type () Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: The if, The if...else, The if...else if...else Decision Control

Statements, Nested if Statement, The while Loop, The for Loop. The continue and break Statements

UNIT II

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, and Command Line Arguments.

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as a return value; Dictionaries: operations and methods; advanced list processing - list comprehension.

UNIT III

Files and **Exception:** Text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT IV

Algorithm Analysis: Time and Space complexity analysis, Linear Search and Binary Search; sorting algorithms: Bubble sort, Selection sort, Insertion sort, Merge sort and Quick sort.

Data Structures: Linked Lists, Stack and Queue.

UNIT V

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance the Polymorphism.

Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

References

1. Yashavanth Kanetkar, Aditya Kanetkar, *"Let us Python",* BPB Publication, 2021.
2. Allen B. Downey, *"Think Python: How to think like a co",* 2nd edition,
3. Narasimha Karumanchi, *"Data Structure and Algorithmic Thinking with Python",* Career Monk; First Edition (1 January 2015); Career Monk Publications
4. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser *"Data Structures and Algorithms in Python, An Indian Adaptation"*

EE3251

POWER SYSTEMS LABORATORY - I

Instruction: 3 hours per week
CIE: 25 marks
Credits: 1.5

Course Objectives

- To analyze the performance of various power system components like transmission lines, transformers, relays, alternators.
- To present a problem-oriented knowledge of power system analysis methods.
- To address the underlying concepts and approaches behind analysis of power system network using software tools.
- To identify & formulate solutions to problems relevant to power system using software tools.
- To make use of Artificial Intelligence tools to solve complex problems.

Course Outcomes:

After completion of this course, the students shall be able to:

1. Analyze the performance of transmission lines, electro mechanical and numerical relays.
2. Analyze the characteristics of transformer and alternator useful for short circuit studies.
3. Understand the concept of MATLAB simulation for solving power systems problems.
4. Design and implementation of solving complex problems using Artificial Intelligence tools.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	3	3
CO2	3	3	3	-	3	3
CO3	3	3	3	-	3	3
CO4	3	3	3	-	3	3

List of Experiments

1. Determination of performance characteristics of 3-phase transmission line model. Determination of ABCD parameters of the transmission line model.

2. Determination of Electromechanical IDMT relay and numerical directional over current relay characteristics.
3. Determination of sequence impedances of 3-phase alternator.
4. Determination of sequence impedances of 3-phase transformer.
5. Load Frequency Control of Two area system using MATLAB SIMULINK.
6. Transient Stability analysis using MATLAB SIMULINK.
7. Design of Fuzzy Logic controller – Performing fuzzification, defuzzification and rule base development processes
8. Implementation of Fuzzy Logic controller using tool box
9. Design of Artificial Neural Network – data generation, training and validation
10. Implementation of Artificial Neural Network using tool box.

EE3252

SEMINAR – I

Instruction	:	3 hours per week
Duration of SEE	:	--
SEE	:	--
CIE	:	25 Marks
Credits	:	1.5

Course Objectives

- Identify appropriate topic of relevance.
- Update literature on technical articles of selected topic and develop comprehension.
- Prepare a technical report.
- Deliver presentation on specified technical topic.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	3	3
CO2	3	3	3	-	3	3
CO3	3	3	3	-	3	3
CO4	3	3	3	-	3	3
CO5	3	3	3	-	3	3

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.

2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance, Report in a prescribed format	10
2	Presentation skills	05
3	Preparation of PPT slides	05
4	Questions and answers	05
	TOTAL	25

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

EE3204

POWER SYSTEM STABILITY

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To gain knowledge about the dynamic mechanisms behind angle and voltage stability problems in electric power systems, including physical phenomena and modeling issues.
- To understand the modelling of excitation and prime mover controllers for stability analysis.
- To model low frequency oscillation studies and develop supplementary damping methods.
- To know about sub synchronous oscillations and damping schemes
- To understand Voltage stability, means to improve it.

Course Outcomes

After the completion of this course, students will be able to:

1. Analyze the performance of single machine and multi machine systems under transient, steady state and dynamic conditions.
2. Model excitation and prime mover controllers for stability analysis.
3. Design supplementary excitation systems, stabilizers for improving stability
4. Analyze sub synchronous oscillations and understand various damping schemes to reduce these oscillations.
5. Understand voltage stability and methods of enhancing it.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	3	-	3	-	-	3
CO3	3	-	3	-	-	3
CO4	3	-	3	-	-	3
CO5	3	-	3	-	-	3

UNIT I

Stability Concepts: Basic concept of stability-Types of stability – Stability criteria for single and multi-machine systems –Synchronous machine representation for stability studies – Swing equation for single and multi-machine system – Basic assumptions– Different methods of solution of swing equation–Solution by indirect methods– Runge-Kutta method – Determination of critical time and critical angle.

UNIT II

Excitation models: Hydraulic power and governor models – IEEE standard models – Models for steam turbine – Various Excitation systems, Effect of Excitation systems on Stability.

UNIT III

Low frequency oscillation and supply controls: Transfer function of low frequency oscillation studies – Improving system damping with supplementary excitation – Design of supplementary excitation system – State equation for single machine system – Improving system model with governor control.

UNIT IV

Sub Synchronous oscillations: Turbine generator torsional characteristics, Torsional interaction with power system controls. Sub Synchronous resonance. Damping schemes.

UNIT V

Concept of voltage stability – Characteristics of network, generator and load for voltage stability – Methods of enhancing stability, Transient stability analysis using Transient Energy Function Analysis, Extended Equal Area Criterion – Basics.

References

1. Yao-Nan-Yu, *Power System Dynamics,* Academic Press, 1983.
2. PrabhaKundur, *Power System Stability & Control,* Tata McGraw Hill edition,2006.
3. KR Padiyar, *FACTS Controllers in Power Transmission & Distribution* New AGE International Publishers First edition 2007.
4. Stagg and Elabiad, *Computer Methods in Power systems* - McGraw Hill., 1968.
5. John Machowski, JanuszBialek, Jim Bumby, Power System Dynamics: Stability and Control, Wiley.

EE3205

ADVANCED POWER SYSTEM PROTECTION

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the necessity,operation and applications of various static relays
- To illustrate complex relay characteristics suitable for special applications
- To be familiar with digital protection and relaying algorithms
- To understand application of pilot protection for transmission protection
- To understand application of traveling waves and Wide area measurements

Course Outcomes

After the completion of this course, students will be able to:

1. Apply the scheme of protection using static relays to power system (distribution system and transmission line).
2. Design and realize the complex relay characteristics suitable for special applications in power systems.
3. Realize the concepts and application of digital protection for various equipment in generation, transmission and distribution
4. Apply carrier protection for transmission and distribution
5. Realize the concepts and application of of traveling waves and Wide area measurements

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	3	-	3	-	-	3
CO3	3	-	3	-	-	3
CO4	3	-	3	-	-	3
CO5	3	-	3	-	-	3

UNIT I

Static relays – Concept of level detectors – Time delay circuits – Filters – Thyristors - Triggering circuits and DC power supplies. static relay characteristics: Relays as comparators –Amplitude and Phase comparison schemes – General equation for comparators for different types of relays – Static comparators- Operating principles – Coincidence circuits – Phase splitting methods–Hall effect comparators

UNIT II

Static over current relays: Static over current relays, directional units based on phase and amplitude comparison–Distance relays – Quadrilateral relay – Elliptical relay – Power swings, Loss of synchronism and its effect on distance relays.

UNIT III

Digital Protection: Developments in computer relaying-mathematical basis for protective relaying algorithms, Fourier Transforms – Discrete Fourier transforms- Wavelet transforms. EHV/ UHV transmission line protection based upon traveling wave phenomena – Auto-reclosing – Single pole and three pole auto reclosing.

UNIT IV

Wire Pilot and carrier protection: Carrier protection -Circulating current scheme – Balanced Voltage scheme -Translay scheme – Phase comparison scheme–carrier transfer scheme – carrier blocking scheme

UNIT V

Relaying applications of traveling waves and Wide area measurements:

Introduction - Traveling waves on single-phase lines, three-phase lines, Directional, distance, differential relays, Fault location. Adaptive relaying and examples, Wide area measurement systems and architecture, WAMS based protection concepts.

References

1. Badriram and Viswakarma D.N., *Power System Protection and Switchgear* — Tata McGraw Hill, 2004.
2. Arun.G. Phadke and James S. Thorp, Computer Relaying for Power Systems --Second edition John Wiley Ltd., 2009.
3. Warrington A.R. Van C, *Protective Relays* ,Vol I & II Chapman & Hall, London and John Wiley & Sons, (1977), reprint,2010 .
4. L.P.Singh, *Digital Protection*, Wiley Eastern Ltd., 1994.
5. Warrington A.R. Van C, *Protective Relays* ,Vol I & II Chapman & Hall, London and John Wiley & Sons, (1977), reprint,2010 .
6. Mason C.R. *The art and science of Protective Relaying,* Wiley & Sons, 1956.
7. Arun G. Phadke, James S. Thorp, Computer Relaying for Power Systems, Second Edition, A John Wiley and Sons, Ltd., Publication, 2009.

EE3206

REAL TIME APPLICATIONS IN POWER SYSTEMS

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To prepare the students to understand
- The concept of state estimation and also the solution techniques of the state estimation problem.
- The methodology for detection and identification of bad data from the available measurements in the Energy control centre.
- The concepts of power system security and methods for analyzing the system security.
- The need of computer control of power system and necessity of different softwares available in Energy control centre.

Course Outcomes

After the completion of this course, students will be able to:

1. Able to estimate the state of given power system using WLS method for the available measurements in the energy control centre.
2. Able to choose suitable state estimation solution technique for a given power system network.
3. Able to detect and identification of bad data for the set of measurements available in the energy control centre.
4. Able to analyze the security of a given power system using different methods.
5. Able to understand the need of the computer control of power system and also the significance of different software's available in the energy control centre.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	3	-	3	-	-	3
CO3	3	-	3	-	-	3
CO4	3	-	3	-	-	3
CO5	3	-	3	-	3	3

UNIT I

State Estimation: Introduction, Power system state estimation, Types of measurements, Linear weighted least square (WLS) estimation theory, DC Load flow based WLS state estimation, Linearised model of WLS state estimation of Non-linear AC power systems, sequential and non-sequential methods to process measurements, typical results of state estimation on an Ac network.

UNIT II

Types of State Estimation: State estimation by conventional WLS (normal equations), orthogonal decomposition and its algorithm, hybrid method. Tracking of state estimation, Dynamic state estimation.

UNIT III

Advanced Topics in State Estimation: Detection and identification of bad measurements, estimation of quantities not being measured, Network observability and pseudo-measurements, observability by graphical technique and triangularisation approach, Optimal meter placement, Application of power system state estimation.

UNIT IV

Power System Security Analysis: Concept of security, Security analysis and monitoring, factors affecting power system security, detection of network problems, an overview of security analysis, contingency analysis for generator and line outages by interactive linear power flow (ILPF) method, network sensitivity factors.
Contingency selection

UNIT V

***Computer control of Power Systems*:** Need for real-time and computer control of power systems, operating states of a power system, Supervisory control and Data acquisition system (SCADA), implementation considerations, energy control centers, software requirements for implementing the above functions.

References

1. Allen J. Wood and Bruce Woolen berg: Power System Generation, Operation and Control, John Wiley and Sons, 1996.
2. John J. Grainger and William D Stevenson Jr.: Power System Analysis, McGraw Hill ISE, 1994.
3. E. Hands chin: Real-time control of electrical power systems, Elsevier Pub. Co, 1988
4. IEEE Proc. July 1974, Special Issue on Computer Control of Power Systems.

EE3141

MODERN CONTROL THEORY

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To provide the fundamentals required to model a control system in state space and check its controllability and observability.
- To educate the students about non-linear systems behavior and the methods to determine their stability.
- To make then students thorough with Lyapunov stability analysis.
- To familiarize the students with the concept of optimal control and how to determine optimum for functional using calculus of variations.
- To introduce the concept of Adaptive control and explain how to design a Model Reference Adaptive System.

Course Outcomes

After the completion of this course, students shall be able to:

1. Model any control system in state space.
2. Understand the behavior of nonlinear system and methods of determining stability.
3. Determine stability of nonlinear system using Liapunov method.
4. Formulate optimal control problem and determine optimum of functionals.
5. Understand and design adaptive control problem.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	2
CO2	3	-	3	-	-	2
CO3	3	-	3	-	-	2
CO4	3	-	3	-	-	2
CO5	3	-	3	-	-	2

Syllabus Contents

UNIT I

Review of state variable representation of systems - Controllability and Observability – Model control of single input – single output systems (SISO), Controllable and Observable companion forms – Effect of state feedback on Controllability and Observability, Pole placement by state feedback.

UNIT II

Classification of Non-linearities: Phenomenon exhibited by the nonlinearities – Limit cycles – Jump resonance, Sub-harmonic oscillations – Phase plane analysis – Singular points – Construction of phase plane trajectories – Isocline method – Delta method – Measurement of time on phase plane trajectories.

UNIT III

Concept and definition of stability - Lyapunov stability - Lyapunov's first and second methods - Stability of linear time invariant systems by Lyapunov's second method - Generation of Lyapunov functions- Variable gradient method - Krasooviski's method.

UNIT IV

Formulation of optimal control problems - Calculus of variations – Fundamental concepts –Functionals – Variation of functionals – Fundamental theorem of calculus of variations - Boundary conditions – Constrained minimization – Dynamic programming – Hamilton Principle of optimality, Jacobi Bellman equation – Potryagins minimum principle.

UNIT V

Introduction to adaptive control, types of adaptive control systems. Design of model reference adaptive control systems using M/T rule and Lyapunov stability theorem.

References

1. I.J Nagarath ,M.Gopal *Control Systems Engineering,* fifth edition , New Age International Publishers, 1984 Wiley Eastern Ltd.
2. Ogata K, *Modern Control Engineering,* Prentice Hall, 1997. Donald E Kirk, optimal control theryAn introduction
3. Karl J AstromBjronwihenmark, *Adaptive control* second edition – Pearson education.

EE 3142

SMART GRID TECHNOLOGIES

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To group various aspects of the smart grid,
- To defend smart grid design to meet the needs of a utility
- To select issues and challenges that remain to be solved
- To analyze basics of electricity, electricity generation, economics of supply and demand, and the various aspects of electricity market operations in both regulated and deregulated environment.

Course Outcomes

After the completion of this course, students will be able to:

- Analyze the structure of an electricity market in either regulated or deregulated market conditions.
- know the advantages of DC distribution and developing technologies in distribution
- Discriminate the trade-off between economics and reliability of an electric power system.
- Differentiate various investment options (e.g. generation capacities, transmission, renewable, demand-side resources, etc) in electricity markets.
- Analyze the development of smart and intelligent domestic systems.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	2	2
CO2	3	-	3	2	2	2
CO3	3	-	3	2	2	2
CO4	3	-	3	2	2	2
CO5	3	-	3	2	2	2

UNIT–I: INTRODUCTION Introduction to smart grid - Electricity network - Local energy networks- Electric transportation - Low carbon central generation - Attributes of the smart grid - Alternate views of a smart grid. SMART GRID TO EVOLVE A PERFECT POWER SYSTEM: Introduction- Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

UNIT–II: DC DISTRIBUTION AND SMART GRID AC Vs DC sources-Benefits of and drives of DC power delivery systems - Powering equipment and appliances with DC-Data centers and information technology loads - Future neighborhood-Potential future work and research. INTELLIGRID ARCHITECTURE FOR THE SMARTGRID: Introduction- Launching intelli-grid –Intelligrid today - Smart grid vision based on the intell-igrid architecture-Barriers and enabling technologies.

UNIT–III: DYNAMIC ENERGY SYSTEMS CONCEPT Smart energy efficient end use devices-Smart distributed energy resources - Advanced whole building control systems-Integrated communications architecture - Energy management-Role of technology in demand response- Current limitations to dynamic energy management-Distributed energy resources Overview of a dynamic energy management-Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.

UNIT–IV: ENERGY PORT AS PART OF THE SMART GRID: Concept of energy - Port, generic features of the energy port. POLICIES AND PROGRAMS TO ENCOURAGE END – USE ENERGY EFFICIENCY: Policies and programs in action - multinational - national-state-city and corporate levels. MARKET IMPLEMENTATION: Framework-factors influencing customer acceptance and response - program planning - monitoring and evaluation.

UNIT–V: EFFICIENT ELECTRIC END–USE TECHNOLOGY ALTERNATIVES Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating - hyper efficient appliances - Ductless residential heat pumps and air conditioners - Variable refrigerant flow air conditioning-Heat pump water heating - Hyper efficient residential appliances - Data center energy efficiency- LED street and area lighting - Industrial motors and drives - Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage - Industrial energy management programs - Manufacturing process-Electro-technologies, Residential, Commercial and industrial sectors.

TEXT BOOKS: 1. Clark W Gellings, “The Smart Grid, Enabling Energy Efficiency and Demand Side Response”- CRC Press, 2009. 2. Jean Claude Sabonnadière, NouredineHadjsaïd, “Smart Grids”, Wiley-ISTE, IEEE Press, May 2012

References

1. Janaka Ekanayake, KithsiriLiyanage, Jianzhong.Wu, Akihiko Yokoyama, Nick Jenkins, “Smart Grid: Technology and Applications”- Wiley, 2012.
2. James Momoh, “Smart Grid: Fundamentals of Design and Analysis” - Wiley, IEEE Press, 2012.

EE 3143

GRID INTEGRATION OF DISTRIBUTED GENERATION

Instruction: 3 periods per week | Duration of SEE: 3 hours
CIE: 40 marks | SEE: 60 marks
Credits: 3

Objectives:

- To study about various types of power generation resources to be connected in distributed generation system.
- To know the architecture of smart grid with integrated distribution generation with various plants.
- To get the knowledge on smart grid and how will gain the efficient power to the distributed end.
- To get the knowledge of Smart grid to evolve a perfect power system

Course Outcomes:

After completion of the course the student will able to:

- Understand about the distribution generation system connected with various power generation plants.
- Gain the knowledge on smart grid by various techniques for better efficiency in transmitting the power.
- Know about the integration of distribution generation with various plants to the smart grid.
- Overview of the perfect power system configurations.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	3	-
CO2	3	-	3	3	3	-
CO3	3	-	3	3	3	-
CO4	3	-	3	3	3	-

UNIT- I

Introduction to Distributed Generation: The development of the electrical power system - Value of distributed generation and network pricing – Reasons for distributed generation - The future development of distributed generation - Distributed generation and the distribution system - Technical impacts of generation on the distribution system - Economic impact of distributed generation on the distribution system - Impact of distributed generation on the transmission system - Impact of distributed generation on central generation.

UNIT-II

Distributed generation plant Combined heat and power plants - Renewable energy generation - Small-scale hydro generation - Wind power plants - Offshore wind energy - Solar photovoltaic generation

UNIT-III

Distributed generators and their connection to the system - Distributed generators - Synchronous generators - Induction generators - Doubly fed induction generator - Full power converter (FPC) connected generators - System studies - Load flow studies in a simple radial system - Load flow studies in meshed systems - Symmetrical fault studies - Unbalanced (asymmetrical) fault studies - Case studies - Steady-state voltages under peak and minimum loading - Electromagnetic transient studies.

UNIT-IV

DC Distribution - AC vs DC sources-Benefits of and drives of DC power delivery systems-Powering equipment and appliances with DC-Data centers and information technology loads-Future neighborhood - Potential future work and research.

UNIT-V

Smart Grid to Evolve a Perfect Power System - Electricity Network-Local energy networks-Electric transportation- Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid. Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

References

1. “Distributed Generation” by N.Jenkins, J.B. Ekanayake & G. Strbac
2. Clark W Gellings, “The Smart Grid, Enabling Energy Efficiency and Demand Side Response”- CRC Press, 2009.
3. Janaka Ekanayake, Kithsiri Liyanage,Jianzhong.Wu, Akihik Yokoyama, Nick Jenkins, “Smart Grid: Technology and Applications”- Wiley, 2012.
4. IEEE 1547. IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems; 2003.
5. James Momoh, “Smart Grid : Fundamentals of Design and Analysis”- Wiley, IEEE Press, 2012.
6. Horlock J.H. Cogeneration: Combined Heat and Power Thermodynamics and Economics. Oxford: Perga

EE3241

REACTIVE POWER CONTROL AND VOLTAGE STABILITY

Instruction: 3periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the relation between reactive power and voltage stability.
- To analyze the reasons for voltage collapse phenomenon.
- To understand various ways of assessing voltage stability and methods of improving voltage stability.
- To understand reactive power management and online voltage stability analysis.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand the requirements of reactive power control.
2. Analyze the reasons for voltage collapse phenomenon.
3. Understand various ways of assessing voltage stability.
4. Know and apply different methods of improving voltage stability.
5. Have insights of reactive power management and online voltage stability analysis.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	3	-	3	-	-	3
CO3	3	-	3	-	-	3
CO4	3	-	3	-	-	3
CO5	3	-	3	-	-	3

UNIT I

Concepts of power in AC transmission systems – reactive loss characteristics – operation of transmission lines under no-load, heavy load conditions – Voltage regulation relations with reactive power – line loadability – governing effects on reactive power flow – reactive power transient stability – reactive power requirements for control – system MVAR mismatch – constraints, effects and practical aspects of reactive power flow problems.

UNIT II

Reactive power and voltage collapse - Voltage stability - classification, analysis and modelling of voltage collapse – basic aspects of voltage stability, security and transient voltage stability – Power transfer at voltage stability limit – different expressions and relations between reactive power and system stability - loading of transmission system at voltage stability.

UNIT III

Voltage stability indicators – P-V and Q-V curves – criteria of voltage stability – different voltage stability indicators – voltage stability indicators – singular value decomposition – expressions for investigate the voltage security – voltage stability evaluation – factors effecting voltage stability – voltage stability relations with off-nominal tap ratios and source to load reactances – Power system security analysis – computation of voltage stability limits – contingency analysis.

UNIT IV

Voltage control and improvement of voltage stability – role and modelling of transformers – OLTC tap settings, effects and practical aspects on voltage stability – methods of improving voltage stability – series compensation – optimal load shedding – facts devices – advantages of fact devices.

UNIT V

Advanced topics in voltage stability: On - Line Voltage Stability Monitoring - Feasibility of online collaborative voltage stability control of power systems - A Fast Calculation Static Voltage Stability Index Based on Wide Area Measurement System - Improving Voltage Stability by Reactive Power Reserve Management.

References

1. An introduction to reactive power control and voltage stability in power transmission systems – Abhijit Chakrabarti, D.P Kothari, A.K. Mukhopadhyay, Abhinandan De – PHI – 2010.
2. Research Papers:

a. Line Voltage Stability Monitoring - IEEE transactions on power systems, vol. 15, no. 4, November 2000.

b. Improving Voltage Stability by Reactive Power Reserve Management - Feng Dong, Badrul H. Chowdhury, Mariesa L. Crow, LeventAcar, IEEE transactions on power systems, vol. 20, no. 1, February 2005.

c. Feasibility of online collaborative voltage stability control of power systems -W. Du, Z. Chen, H.F. Wang, R. Dunn - IET Gener. Transm. Distrib., 2009, Vol. 3, Issue. 2, pp. 216–224.

d. A Fast Calculation Static Voltage Stability Index Based on Wide Area Measurement System - TianjiaoPu, Zhao Zhang, Ting Yu , Wei Han, And Lei Dong – 2014.

EE3124

HYBRID ELECTRICAL VEHICLES

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the basics of electric and hybrid electric vehicles and their working
- To understand the basics of batteries and their role for electric/hybrid vehicle applications
- To obtain the knowledge of various types of electric/hybrid vehicles
- To understand the real time challenges in the implementation of this technology

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand basics of electric and hybrid electric vehicles both conceptually and mathematically so that clear understanding from basics physics is achieved.
2. Have the knowledge of battery behavior for electric vehicle application.
3. Understand different types of Electric/Hybrid vehicles technologies available and their applications.
4. Analyze challenges in implementing electric/hybrid vehicle technology by looking into various charging topologies and their impact on distribution systems.
5. Analyze various electric drives suitable for hybrid electric vehicles.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	2
CO2	3	-	3	-	-	2
CO3	3	-	3	2	-	2
CO4	3	-	3	2	-	2
CO5	3	-	3	2	-	2

UNIT I

Introduction to Electric Vehicles: Sustainable Transportation - EV System – EV - Advantages - Vehicle Mechanics - Performance of EVs - Electric Vehicle drivetrain - EV Transmission Configurations and components-Tractive Effort in Normal Driving - Energy Consumption - EV Market - Types of Electric Vehicle in Use Today – Electric Vehicles for the Future.

UNIT II

Electric Vehicle Modelling - Consideration of Rolling Resistance – Transmission Efficiency - Consideration of Vehicle Mass - Tractive Effort - Modelling Vehicle Acceleration - Modelling Electric Vehicle Range -Aerodynamic Considerations - Ideal Gearbox Steady State Model - EV Motor Sizing - General Issues in Design.

UNIT III

Introduction to electric vehicle batteries - electric vehicle battery efficiency – electric vehicle battery capacity - electric vehicle battery charging - electric vehicle battery fast charging - electric vehicle battery discharging - electric vehicle battery performance – testing.

UNIT IV

Hybrid Electric Vehicles - HEV Fundamentals -Architectures of HEVs- Interdisciplinary Nature of HEVs - State of the Art of HEVs - Advantages and Disadvantages - Challenges and Key Technology of HEVs - Concept of Hybridization of the Automobile-Plug-in Hybrid Electric Vehicles - Design and Control Principles of Plug-In Hybrid Electric Vehicles - Fuel Cell Hybrid Electric Drive Train Design - HEV Applications for Military Vehicles.

UNIT V

Advanced Topics - Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles - The Impact of Plug-in Hybrid Electric Vehicles on Distribution Networks – Sizing Ultra capacitors for Hybrid Electric Vehicles.

References

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles –Fundamentals, Theory and Design – Mehrdad Ehsani, UiminGao and Ali Emadi - Second Edition - CRC Press, 2010.
2. Electric Vehicle Technology Explained - James Larminie, John Lowry – John Wiley & Sons Ltd, - 2003.
3. Electric Vehicle Battery Systems – Sandeep Dhameja – Newnes - 2002.
4. Hybrid electric Vehicles Principles and applications with practical perspectives Chris Mi, Dearborn - M. AbulMasrur, David WenzhongGao - A John Wiley & Sons, Ltd., - 2011.
5. Electric & Hybrid Vehicles – Design Fundamentals-IqbalHussain, SecondEdition, CRC Press, 2011.
6. Research Papers:

a. The Impact of Plug-in Hybrid Electric Vehicles on Distribution Networks: a Review and Outlook - Robert C. Green II, Lingfeng Wang andMansoorAlam - 2010 IEEE.

b. Sizing Ultracapacitors For Hybrid Electric Vehicles - H. Douglas P Pillay 2005 IEEE.

c. Review of Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles - Murat Yilmaz, and Philip T. Krein, - IEEE transactions on power electronics, vol. 28, no. 5, may 2013.

EE 3152

DIGITAL CIRCUITS AND LOGIC DESIGN

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To know the concepts of Combinational circuits.
- To know the concepts of Sequential Circuits
- To know the concepts of Asynchronous Circuits- Analysis
- To understand the concepts digital circuits design

Course Outcomes

The students will

1. Design contact networks and identify symmetric functions and acquire the knowledge of combinational circuit design with PLA, PROM and PAL.
2. Develop mealy and more models and analyze and synthesize synchronous and asynchronous sequential circuits and simplify the circuits.
3. Identify and design of pulse mode and fundamental mode circuits.
4. Understand races, cycle and hazards and testing of sequential circuits and determine the transfer and homing sequences of a given state table.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	-	1
CO2	3	-	3	2	-	1
CO3	3	-	3	2	-	1
CO4	3	-	3	2	-	1

UNIT I

Relay contacts-Analysis and synthesis of contact networks - Symmetric networks - Identification of symmetricfunctions-Combinational circuit design with Programmable Logic Array, Programmable Read-Only Memory and Programmable Array Logic.

UNIT II

Synchronous sequential circuit - Mealy and Moore models - Sequential circuit analysis - Synthesis of synchronous sequential circuits - Incompletely specified circuits.

UNIT III

Simplification of Sequential Circuits - State equivalence- State reduction in completely specified circuits using Inspection, Partitioning and Implication table - State reduction in incompletely specified sequential circuits using Merger diagrams.

UNIT IV

Types of Asynchronous Circuits- Analysis of Pulse-mode asynchronous circuits-Synthesis of pulse-mode asynchronous circuits-Analysis of fundamental-mode circuits-Synthesis of fundamental-mode circuits.

UNIT V

Introduction to Races, Cycles and Hazards - Avoidance of race conditions – Race-free state assignments and sequential logic circuit testing.

References

1. Z.Kohavi, *Switching and Finite Automata Theory,* Tata McGraw Hill, 48th Reprint 2010.
2. Victor P.Nelson, H.Troy Nagle, Bill D Caroll, J.David Irwin, *Digital Logic Circuit Analysis and Design*, Prentice Hall International, 1996.

EE 3122

OPTIMIZATION METHODS

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the concepts of single variable and multivariable optimization with and without constraints
- To make the students understand about linear and nonlinear optimization problems.
- To make the students understand about Evolutionary computational techniques

Course Outcomes

After the completion of this course, the students shall be able to:

1. Formulate practical problems to mathematical models.
2. Solve single, multivariable methods with and without constraints.
3. Solve linear and nonlinear optimization problems
4. Solve evolutionary computations
5. Understand the Advanced topics in optimization and their applications

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	-
CO2	3	-	3	-	-	-
CO3	3	-	3	-	-	-
CO4	3	-	3	-	-	2
CO5	3	-	3	-	-	2

Syllabus Contents

UNIT I

Classical Optimization techniques*:* Introduction to optimization and design optimization, optimum design problem formulation, Single variable optimization- Multivariable optimization with and without constraints – Multi variable optimization with inequality constraints – Solution by Lagrangian multipliers - Kuhn-Tucker conditions.

UNIT II

Linear Programming: Formulation and standard form of LP problem, Basic definitions and theorems – Solution of a system of linear simultaneous equations – simplex method and its algorithm – Revised simplex method – Big-M method – Duality in LP and primal dual relations – Dual simplex method.

UNIT III

***Non-Linear Programming*:** One dimensional minimization methods – Introduction – Elimination methods – Unrestricted search, Exhaustive search, Dichotomous search, Fibonacci methods. Unconstrained optimization techniques- Univariate and Powell's pattern search method, steepest descent method.

UNIT IV

Metaheuristics Algorithms 1:

Science based Algorithms: Simulated annealing - metropolis criterion - algorithm - pseudo code- examples.

Human based Algorithms: Tabu search- different strategies - Algorithm- pseudo code- examples.

Evolution based Algorithms: Genetic algorithms – binary encoding, real encoding, permutation encoding - different selection process - crossover for different encodings - mutation for different encodings - Elitism - pseudo code -Genetic Algorithm examples.

UNIT V

Metaheuristics Algorithms 1:

Swarm intelligence-based algorithms: Particle Swarm Optimization - exploration - exploitation - parameters of PSO - personal best - global best-Algorithm - pseudo code - examples- Limitations of original PSO - PSO variants.

Introduction to Multi-objective optimization: Need of multi-objective approach-Pareto optimality - examples - Non dominated Sorting Genetic algorithm II- Algorithm - pseudo code - applications.

References

1. Engineering Optimization, Theory and Practice - Singiresu S. Rao, S. S. Rao – Fourth edition – New Age Internationals – 2009.
2. Introduction to Optimum design, Jasbir S. Arora, - Third Edition – Elsevier – 2013.
3. Optimization methods for Engineers, N.V.S. Raju – PHI – 2014.
4. Introduction to Genetic Algorithms, S.N.Sivanandam, S.N Deepa – Spinger – 2013.
5. 5. Search and Optimization by Metaheurstics-Techniques and algorithms inspired by nature, Ke-LinDu, M.N.S Swamy - Springer international publishing - 2016
6. Yang, Xin-She, Nature-Inspired Metaheuristic Algorithms, 2010/07/25
7. Link: https://www.researchgate.net/publication/235979455_Nature-Inspired_Metaheuristic_Algorithms
8. https://www.researchgate.net/publication/228346477_Tabu_Search
9. Alhammadi, H. Y., & Romagnoli, J. A. (2004). Process design and operation. Computer Aided Chemical Engineering, 264–305.

10. Ant Colony Optimization for Mixed-Variable Optimization Problems: IEEE Transactions on evolutionary computation, vol. 18, no. 4, august 2014.

EE3251

SUBSTATION DESIGN AND AUTOMATION

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To introduce Substation Design, Construction and Commissioning Process
- To study the high voltage equipment's used in Substations
- To study the different bus bar configuration used in Substations
- To study the grounding and protection systems used in Substations
- To study automation of the substations

Course Outcomes:

At the end of the Course, the Student will be able to:

- Describe the main consideration in the process of substation design
- Describe the working principles of substation switching equipment
- Describe the different types of bus configurations
- Design criteria of substation grounding and protection
- Describe the substation communication (SCADA)

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	1	-
CO2	3	-	3	-	1	-
CO3	3	-	3	-	1	-
CO4	3	-	3	-	1	-
CO5	3	-	3	-	1	-

UNIT-I

INTRODUCTION ABOUT SUBSTATION DESIGN: Background, Needs Determination, Budgeting, Financing, Traditional and innovative Substation Design, Site Acquisition, Design, Construction and Commissioning Process.

UNIT-II

HIGH VOLATGE SWITCHING EQUIPMENT: Ambient conditions, Disconnect switches, Load Break switches, high speed grounding switches, power fuses, circuit switches, circuit breakers, GIS substations.

UNIT-III

TYPES OF SUBSATIONS & BUS/SWITCHING CONFIGURATIONS: Transmission substation, distribution substation, collector substation, switching substations, gas insulated substations, air insulated substations, bus configurations: single bus, double bus, double break, main and transfer bus, double bus, single breaker, ring bus, break-and-a-half, Comparison of configurations.

UNIT-IV

SUBSATION GROUNDING AND PROTECTION: Reasons for substation grounding system, accidental ground circuit, design criteria, lightning stroke protection, lightning parameters, empirical design methods, fire hazards, fire protection measures, fire protection selection.

UNIT-V

Substation Automation: Technical Issues, System Responsibilities, System Architecture, Substation Host Processor, Substation LAN, User Interface, Communications Interfaces, Protocol Considerations. The New Digital Substation, Process Level, Protection and Control Level, Station Bus and Station Level, Substation Automation Architectures, Legacy Substation Automation System, Digital Substation Automation Design, New versus Existing Substations. Drivers of Transition, Migration Paths and the Steps Involved, Value of Standards in Substation Automation, Substation Automation (SA) Application Functions, Integrated Protection Functions: Traditional Approach and IED-Based Approach. Automation Functions, Enterprise-Level Application Functions

References

1. John D. McDonald, “Electrical Power Substation Engineering”, CRC Press, 2nd Edition, 2001.
2. R. S. Dahiya, VinayAttri,”Sub-Station Engineering Design & Computer Applications” S K Kataria and sons Publications, 1st Edition, 2013.
3. P. S. Satnam, P. V. Gupta, “Substation Design and Equipment” Dhanapat Rai Publications, 1st Edition, 2013.
4. Mini S. Thomas and John Douglas McDonald, Power System SCADA and Smart Grids, CRC Press, 2015.

OE901EE

WASTE TO ENERGY

Instruction: 3periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To know the various forms of waste
- To understand different gasification systems.
- To understand the processes of Biomass Pyrolysis.
- To learn the technique of Biomass Combustion.
- To learn the technique of Biomass technologies

Course Outcomes

After the completion of this course, the students shall be able to:

- Understand the concept of conservation of waste
- Identify the different forms of wastage
- Chose the best way for conservation to produce energy from waste
- Explore the ways and means of combustion of biomass
- Develop a healthy environment for the mankind

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	3	1
CO2	3	-	3	2	3	1
CO3	3	-	3	2	3	1
CO4	3	-	3	2	3	1
CO5	3	-	3	2	3	1

Syllabus Contents

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

References

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

OE901EE

POWER PLANT CONTROL AND INSTRUMENTATION

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives:

The course should enable the students to:

- The operation of different types of power plants.
- The basic working principle of instruments for measurement of electrical and non-electrical quantities like Temperature Pressure flow level measurements.
- The instrumentation and protection systems applied in thermal power plant.
- The control techniques employed for the operation of modern power generation plant

Course Outcomes:

After successful completion of the course, students should be able to:

- Explain the different methods of power generation. Along with Piping and Instrumentation diagram of boiler.
- Select various measurements involved in power generation for measuring electrical and non-electrical parameters.
- Identify the different types of analyzers used for scrutinizing boiler steam and water.
- Model different types of controls and control loops in boilers.
- Illustrate the methods of monitoring and control of different parameters like speed, vibration of turbines.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	2	1
CO2	3	-	3	-	2	1
CO3	3	-	3	-	2	1
CO4	3	-	3	-	2	1
CO5	3	-	3	-	2	1

UNIT - I

Overview Of Power Generation Classes: Brief survey of methods of power generation, hydro, thermal, nuclear, solar and wind power, importance of instrumentation in power

generation, thermal power plants, block diagram, details of boiler processes, Piping and Instrumentation diagram of boiler, cogeneration.

UNIT - II

Measurements In Power Plants Classes: Electrical measurements, current, voltage, power, frequency, power factor etc., non-electrical parameters, flow of feed water, fuel, air and steam with correction factor for temperature, steam pressure and steam temperature, drum level measurement, radiation detector, smoke density measurement, dust monitor.

UNIT - III

Analyzers In Power Plants Classes: Flue gas oxygen analyzer: Analysis of impurities in feed water and steam, dissolved oxygen analyzer. Chromatography, pH meter, fuel analyzer, pollution monitoring instruments.

UNIT - IV

Control Loops in Boiler Classes: Combustion control, air / fuel ratio control, furnace draft control, drum level control, main steam and reheat steam temperature control, super heater control, air temperature, distributed control system in power plants, interlocks in boiler operation.

UNIT - V

Turbine Monitoring and Control Classes: Speed, vibration, shell temperature monitoring and control, steam pressure control, lubricant oil temperature control, cooling system.

References

1. Sam G. Dukelow, The Control of Boilers, Instrument Society of America, 2nd Edition, 2010.
2. P.K. Nag, „Power Plant Engineering", Tata McGraw-Hill, 1st Edition, 2001.
3. S.M. Elonka and A.L. Kohal, "Standard Boiler Operations", Tata McGraw-Hill, 1st Edition, 1994.
4. R K Jain, "Mechanical and Industrial Measurements", Khanna Publishers, 1st Edition, 1995.
5. E Al Wakil, "Power Plant Engineering", Tata McGraw-Hill, 1st Edition, 1984.

OE941CS

BUSINESS ANALYTICS

Instruction: 3periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand the role of business analytics within an organization.
- To analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- To become familiar with processes needed to develop, report, and analyze business data.
- To use decision-making tools/Operations research techniques and manage business process using analytical and management tools.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand the basic concepts of business analytics.
2. Identify the application of business analytics and use tools to analyze business data.
3. Become familiar with various metrics, measures used in business analytics.
4. Illustrate various descriptive, predictive and prescriptive methods and techniques.
5. Model the business data using various business analytical methods and techniques.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	1
CO2	3	-	3	-	-	1
CO3	3	-	3	-	-	1
CO4	3	-	3	-	-	1
CO5	3	-	3	-	-	1

UNIT I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics** - Linear Programming (LP) and LP model building.

UNIT V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

References

1. U Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017.
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015.
3. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015.

Web Resources

1. https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2. https://nptel.ac.in/courses/110105089/

OE 941 ME	**OPERATION RESEARCH**					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To understand the dynamic programming to solve problems of discrete and continuous variables
2	To apply the concept of non-linear programming and carry out sensitivity analysis
3	To understand deterministic and probabilistic inventory control models.

Course Outcomes:	
After the completion of this course, the students shall be able to:	
CO-1	To understand the basics of OR, including mathematical modeling, feasible solutions and optimization.
CO-2	Able to carry out sensitivity analysis.
CO-3	Apply PERT/CPM in project management.
CO-4	Select appropriate inventory control model.
CO-5	Able to apply dynamic programming and understand the concept of non-linear programming.

Course Outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	1	3	2	1	2
CO-2	3	1	2	3	2	-
CO-3	1	3	3	1	2	2
CO-4	3	2	1	3	1	1
CO-5	2	1	3	2	2	2

Unit – I
Development, Different Phases, Characteristics, Operations Research models and applications. Linear Programming Problem: Introduction, Basic Assumptions, Formulation, graphical method, simplex method: Big M and Two Phase method.

Unit – II
DUALITY: Duality theory, primal-dual relationships, Economic interpretation, Dual simplex method, Post optimal or sensitivity analysis.

Unit – III
Project Management: Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity. **Inventory models** – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

Unit – IV
Sequencing Models: Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines. **Game Theory**: Introduction, Characteristics of Game Theory, Dominance theory, Mixed strategies (2 x 2, m x 2), Algebraic and graphical methods. **Nonlinear programming problem:** - Kuhn-Tucker conditions.

Unit – V
Queuing models - Queuing systems and structures – Notation parameter – Single server and multi server models – Poisson arrivals – Exponential service times – with finite population – Infinite population. Dynamic Programming: Characteristics, principle of optimality, deterministic problems.

Suggested Reading:

1	H.A. Taha, Operations Research, An Introduction, PHI,2008
2	H.M. Wagner, Principles of Operations Research, PHI, Delhi,2010
3	J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers,Delhi, 2008.
4	Frederick S. Hillier, Gerald J. Lieberman, Operations Research, 10thEdition, McGraw Hill Pub. 2017.
5	Panner selvam, Operations Research: Prentice Hall of India, 2010.
6	Ronald L. Rardin, Optimization in Operations Research, First Indian Reprint, Pearson Education Asia. 2002,

OE942ME

INDUSTRIAL SAFETY

Instruction: 3periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To understand industrial safety and remember features of factory act 1948.
- Analyze maintenance tools, corrosion preventive measures and fault causes.
- Assess the importance of periodic inspections and maintenance.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand the necessity of industrial safety and remember features of factory act 1948 for health and safety.
2. Analyze the tools used for maintenance.
3. Become thorough of the corrosion preventive measures.
4. Analyze the causes of faults and draw decision trees.
5. Understand importance of periodic maintenance and inspection procedures.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	1
CO2	3	-	3	-	-	1
CO3	3	-	3	-	-	1
CO4	3	-	3	-	-	1
CO5	3	-	3	-	-	1

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

References

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

OE944CE

COST MANAGEMENT OF ENGINEERING PROJECTS

Instruction: 3periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- Introduce the concepts of cost management, inventory valuation, decision making
- Fundamentals of cost overruns, project execution and technical activities
- Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand strategic cost management process, control of cost and decision making based on the cost of the project.
2. Appreciate detailed engineering activities of the project and execution of projects
3. Prepare project report and network diagram
4. Plan Cost Behavior, Profit Planning, Enterprise Resource Planning, Total Quality Management.
5. Apply various quantitative techniques for cost management

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	1
CO2	3	-	3	-	-	1
CO3	3	-	3	-	-	1
CO4	3	-	3	-	-	1
CO5	3	-	3	-	-	1

Syllabus Contents

UNIT I

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

UNIT II

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 nontechnical 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.

UNIT III

Project commissioning: mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

UNIT IV

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.

UNIT V

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

References

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

OE945ME

COMPOSITE MATERIALS

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- Study the concepts of composite construction.
- Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.
- Apply the concepts for design of multi-storey composite buildings.
- Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.
- Study the concepts of composite construction.

Course Outcomes

After the completion of this course, the students shall be able to:

- Understand the fundamentals of composite construction, and analysis and designs of composite beams.
- Analyse and design the composite floors Illustrate the manufacturing of metal matrix composites and outline the properties and applications.
- Select suitable materials for composite columns,
- Analyse composite trusses and understand connection details.
- Analyse and design the multi-storey composite buildings

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	3	-	-	1
CO2	2	-	3	-	-	1
CO3	2	-	3	-	-	1
CO4	2	-	3	-	-	1
CO5	2	-	3	-	-	1

Syllabus Contents

UNIT-I

Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions.
Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

UNIT-II

Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

UNIT-III

Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

UNIT-IV

Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

UNIT-V

Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

References:

1. R.P. Johnson, “Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings”, Blackwell Publishing, Malden, USA, 2004.
2. “INSDAG Teaching Resources for Structural Steel Design”, Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3. “INSDAG Handbook on Composite Construction – Multi-Storey Buildings”, Institute for Steel Development and Growth Publishers, Calcutta, India.
4. “INSDAG Design of Composite Truss for Building”, Institute for Steel Development and Growth Publishers, Calcutta, India.
5. “INSDAG Handbook on Composite Construction – Bridges and Flyovers”, Institute for Steel Development and Growth Publishers, Calcutta, India.
6. IS: 11384-1985, “Code of Practice for Composite Construction in Structural Steel and Concrete”, Bureau of Indian Standards, New Delhi, 1985.

OE 941 BM MEDICAL ASSISTIVE DEVICES

Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40	Marks

Course Objectives :

The course is taught with the objectives of enabling the student to:

1 To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.

2 To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.

3 To develop improved lower-extremity devices

Course Outcomes :

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

CO-1 Apply fundamental knowledge of engineering in rehabilitation

CO-2 Apply analytical skills to assess and evaluate the need of the end-user

CO-3 Develop self-learning initiatives and integrate learned knowledge for problem solving

CO-4 Understand the basics of robotics and apply their principles in developing prosthetics

CO-5 Apply the knowledge of computers in solving rehabilitation problems

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Chapter – I

Introduction to Rehabilitation Engineering, Measurement and analysis of human movement, Disability associated with aging in the workplace and their solutions, clinical practice of rehabilitation engineering.

Chapter – II

Assistive Technology, Seating Biomechanics and systems. Wheeled Mobility: Categories of Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of Wheel chair

propulsion. Power Wheelchair Electrical Systems. Control. Personal Transportation. Auxiliary devices and systems.

Chapter – III

Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual augmentation. Tactual substitution. Measurement tools and processes: fundamental principles, structure, function; performance and behavior. Subjective and objective measurement methods.

Chapter – IV

Rehabilitation Robotics, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

Chapter – V

Augmentative and Alternative communication technology, Computer applications in Rehabilitation Engineering, telecommunications, and Web Accessibility.

Suggested Reading:

1 Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.

2 Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.

3 Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.

4 Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rdEd., CRC Press, Taylor & Francis Group, London, 2006.

OE 942 BM MEDICAL IMAGING TECHNIQUES

Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40	Marks

Course Objectives :

The course is taught with the objectives of enabling the student to:

1 To familiarize the students with various medical imaging modalities.

2 To make learners understand the principles, detectors and operating procedures of X-ray, CT, MRI, ultrasound, PET and SPECT.

3 To make the students learn the advantages, disadvantages and hazards of various medical imaging equipment.

Course Outcomes :

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

CO-1 Interpret the working principle and operating procedure and applications of X-ray equipment.

CO-2 Understand the image reconstruction techniques and applications of CT.

CO-3 Summarize the image acquisition and reconstruction techniques in MRI.

CO-4 Comprehend the working principle, modes and medical applications of ultrasound imaging.

CO-5 Examine the operation and applications of PET, SPECT and radio nuclide instrumentation.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Chapter – I

X ray Imaging: Electromagnetic spectrum, Production of X-rays, X-ray tubes- Stationary and Rotating Anode types, Block diagram of an X-Ray Machine, Collimators and Grids, Timing and Exposure controls. X-Ray Image visualization-Films, Fluorescent screens, Image Intensifiers.

Dental X-Ray machines, Portable and mobile X-Ray units, Mammographic X-Ray equipment,

Digital Radiography and flat panel detectors.

Radiation safety, ALARA principle, Dose units and dose limits, Radiation dosimeters and detectors.

Chapter – II

Computed Tomography: Basic principles, CT number scale, CT Generations. Major sub systems- Scanning system, processing unit, viewing unit, storage unit. Need and Principle of sectional imaging, 2D image reconstruction techniques - Iteration and Fourier methods. Applications of CT - Angio, Osteo, Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Coronary Angiography.

Chapter – III

Magnetic Resonance Imaging: Principles of NMR imaging systems, Image reconstruction techniques-Relaxation processes, imaging/ pulse sequences. Sub systems of an NMR imaging system, NMR detection system, types of coils, biological effects and advantages of NMR imaging.

Functional MRI - The BOLD effect, intra and extra vascular field offsets, source of T2* effects, Creating BOLD contrast sequence optimization sources and dependences of physiological noise in fMRI.

Chapter – IV

Ultrasound Imaging: - Principles of image formation -Imaging principles and instrumentation of A-mode, B-Mode, Gating Mode, Transmission mode and M-mode. Basics of multi-element linear array scanners, Digital scan conversion.

Doppler Ultrasound and Colour Doppler imaging, Image artifacts, Biological effects, Ultrasound applications in diagnosis, therapy and surgery.

Chapter – V

Nuclear Medicine–Radioisotopes in medical diagnosis, Basic instrumentation- Radiation detectors, Pulse height analyzer, Rectilinear scanner, Gamma camera.

Emission Computed Tomography (ECT), Principle and instrumentation of Single Photon Emission Computed Tomography(SPECT) and Positron Emission Tomography (PET). Comparison of SPECT, PET and combined PET/ X-ray CT.

Suggested Reading:

1. Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
2. S Webb, "*The Physics of Medical Imaging*", Adam Highler, Bristol Published by CRC Press, 1988.
3. A C Kak, "*Principle of Computed Tomography*", IEEE Press New York, 1988.
4. Hykes, Heorick, Starchman, *Ultrasound physics and Instrumentation* MOSBY year book, 2nd Ed. 1992.
5. Stewart C. Bushong, *Magnetic Resonance Imaging- physical and biological principles*, MOSBY, 2nd Ed., 1995.

EE271

MINI PROJECT

Instruction	:	4 hours per week
Duration of SEE	:	--
SEE	:	--
CIE	:	50 Marks
Credits	:	2

Course Objectives

- To review available literature and formulate structural engineering problems
- To learn the technique of writing reports and prepare presentation

Course Outcomes

After the completion of this course, the students shall be able to:

1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained
5. Write the documentation in standard format

Guidelines

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter-disciplinary/ industry relevance.
- The students can select a mathematical modelling based/Experimental investigations or Numerical modelling
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	2
CO2	3	3	2	-	-	2
CO3	3	3	2	-	-	2
CO4	3	3	2	-	-	2
CO5	3	3	2	-	-	2

Departmental committee: Supervisor and a minimum of two faculty members

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): **Max. Marks: 50**		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

EE252

POWER SYSTEMS LABORATORY - II

Instruction: 3 hours per week CIE: 25 marks
Credits: 1.5

Course Objectives

- To analyze the performance characteristics of various power system components like transformers, relays and alternators.
- To present a problem-oriented knowledge of power system analysis methods.
- To address the underlying concepts and approaches behind analysis of power system network using software tools.
- To identify & formulate solutions to problems relevant to power system using software tools.
- To make use of Artificial Intelligence tools to solve complex problems.

Course Outcomes:

After completion of this course, the students shall be able to:

1. Analyze the performance of static and numerical relays.
2. Analyze faults which occur in alternators and transformers.
3. Understand power system planning and operational studies like load flows and Economic dispatch.
4. Understand the usage of conventional and heuristic optimization techniques.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	3	3
CO2	3	3	3	-	3	3
CO3	3	3	3	-	3	3
CO4	3	3	3	-	3	3
CO5	3	3	3	-	3	3

List of Experiments

1. Study of Over / Under Frequency relay.
2. Study of static distance relay.
3. Fault analysis on an unloaded alternator.
4. Differential protection of 1-phase transformer.

5. Load flow studies using Power World Software.
6. Economic Load Dispatch using Power World Software.
7. Conventional Linear Programming and Non-Linear Programming using optimization tool box and testing on benchmark functions.
8. Developing programs for Genetic Algorithm processes: population generation, selection, cross over and mutation.
9. Testing Genetic Algorithm on benchmark functions using tool box.
10. Developing program for Particle Swarm Optimization and testing on benchmark functions.

EE254

POWER SYSTEMS LABORATORY - III

(Artificial Intelligence lab for Power Systems)

Instruction: 3 hours per week CIE: 25 marks
Credits: 1.5

Course Objectives

- To test and analyze the performance of relaying equipment.
- To present a problem-oriented knowledge of power system analysis methods.
- To address the underlying concepts and approaches behind analysis of power system network using software tools.
- To identify & formulate solutions to problems relevant to power system using software tools.
- To make use of Artificial Intelligence tools to solve complex power system problems

Course Outcomes:

After completion of this course, the students shall be able to:

- Test the performance characteristics of numerical and static relays.
- Analyze various distribution system protection schemes.
- Understand the concept of MATLAB programming in solving power systems problems.
- Understand power system planning and operational studies like load flows and contingency analysis.
- Optimizing system performance using conventional and heuristic optimization techniques.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	-
CO2	3	3	2	-	-	-
CO3	3	3	2	-	-	-
CO4	3	3	2	-	-	-
CO5	3	3	2	-	-	-

1. Testing of numerical overcurrent relay with Relay Protection Test set.
2. Testing of static distance relay with Relay Protection Test set.

3. Distribution system protection using Feeder Protection unit.
4. Load flow studies and contingency analysis using PSSE.
5. Program for Newton Raphson load flow using MATLAB.
6. Fuzzy Logic based load frequency control of single area and two area systems.
7. Power system Contingency Analysis using Neural Network.
8. Loss minimization of standard IEEE system using Non-Linear Programming
9. Loss minimization of standard IEEE system using Genetic Algorithm.
10. Loss minimization of standard IEEE system using Particle Swarm Optimization.

AC2001EE

ENGINEERING RESEARCH METHODOLOGY IN ELECTRICAL ENGINEERING

Instruction: 3 periods per week
CIE: 40 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To learn the research types, methodology and formulation.
- To know the sources of literature, survey, review and quality journals.
- To understand the research design for collection of research data.
- To understand the research data analysis, writing of research report and grant proposal.

Course Outcomes:

After the completion of this course, students shall be able to:

1. Know the importance of research, the method and the methodology adopted.
2. Do a proper research design for a given research topic.
3. Do the literature survey and the review.
4. Analyze and solve the statistical methods used for the research.
5. Write technical report, research proposals.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	-	2
CO2	3	3	-	-	-	2
CO3	3	3	-	-	-	2
CO4	3	3	-	-	-	2
CO5	3	3	-	-	-	2

UNIT - I

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.

Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Techniques involved in Defining a Problem.

UNIT - II

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet.

Literature Review: Need of Review, Guidelines for Review, Record of Research Review. A review of the smart grid concept for electrical power system, Power Electronics Converters for the Internet of Energy, Direct Torque Control of Induction Machine: A Review.

UNIT - III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

UNIT - IV

Data Collection and Analysis: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non-Parametric methods, Descriptive Statistics, Processing and Analysis of Data.

UNIT - V

Research Report Writing, Publishing: Format of the Research report, Style of writing report, References/Bibliography/Webliography, Preparing the List of Works, Cited, Technical paper writing/Journal report writing. Considerations when selecting a target journal, submitting a manuscript, how to respond to editors and referees, A process for preparing a manuscript. Plagiarism and Academic Integrity.

Research Proposal Preparation: Funding agencies in India and across the Globe, writing a Research Proposal and Research Report, Writing Research Grant Proposal: Minor and Major Research proposals (UGC and AICTE).

References

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. Vijay Upagade and AravindShende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
4. P.Ramdass and Wilson Aruni; Research and Writing across the disciplines; MJP Publishers, Chennai, 2009.
5. Margaret Cargill and Patrick O'Connor: Writing Scientific Research Articles Strategy and Steps, A John Wiley & Sons, Ltd., Publication, 2009.
6. MLA Handbook for Writers of Research Papers, The modern language association of America, New York 2009.

AC101EG

ENGLISH FOR ACADEMIC AND RESEARCH WRITING

Instruction: 3 periods per week
CIE: 40 marks
Credits: 00

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives: To expose the students to...

- Features of Academic writing; different kinds of Academic writing
- Some academic writing skills; the research process; the structure of a research document

Course Outcomes: At the end of the course, the students would be equipped with the knowledge and skills relating to ...

1. Academic writing features; Academic writing kinds; Important academic writing skills
2. The process of research; general research document structure

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	-	2
CO2	3	3	-	-	-	2

UNIT I: Features of Academic Writing

Language: Clear, Correct, Concise, Inclusive; **Tone**: Formal, Objective, Cautious; **Style**: Appropriate, Accurate, Organized; **Ethics**: Honesty, Integrity, Responsibility, Accountability

UNIT II: Kinds of Academic Writing

Essays, Reports, Reviews, Abstracts, Proposals

UNIT III: Academic Writing Skills

Paraphrasing; Summarizing; Quoting; Rewriting; Expansion

UNIT IV: **Research Process**

Selection of Topic, Formulation of Hypothesis, Collection of Data, Analysis of Data, Interpretation of Data, Presentation of Data

UNIT V: Structure of a Research Document

Title, Abstract, Introduction, Literature Survey, Methodology, Discussion, Findings/Results, Conclusion, Documenting Sources (IEEE style)

Suggested Reading:

Bailey, S. (2014). *Academic writing: A handbook for international students*. Routledge.
Gillett, A., Hammond, A., &Martala, M. (2009). *Inside track: Successful academic writing*. Essex: Pearson Education Limited.
Griffin, G. (2006). *Research methods for English studies*. Edinburgh: Edinburgh University Press.

Silyn-Roberts, Heather. (2013). *Writing for Science and Engineering: Papers, Presentations and Reports*(2nd ed.). Elsevier.
Lipson, Charles (2011). *Cite right: A quick guide to citation styles; MLA,APA, Chicago, the sciences, professions, and more* (2nd ed.). Chicago[u.a.]: University of Chicago Press.

AC102

DISASTER MITIGATION & MANAGEMENT

Instruction: 3 periods per week
CIE: 40 marks
Credits: 00

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
- To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
- To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.

Course Outcomes

After the completion of this course, the students shall be able to:

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

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	2
CO2	3	-	3	-	-	2
CO3	3	-	3	-	-	2
CO4	3	-	3	-	-	2

UNIT I

Introduction: Disaster Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT III

Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV

Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

References

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

2 Sahni, Pardeep et al. (Eds.), "Disaster Mitigation Experiences and Reflections", Prentice Hall ofIndia, New Delhi.

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

AC103

SANSKRIT FOR TECHNICAL KNOWLEDGE

Instruction: 3 periods per week
CIE: 40 marks
Credits: 00

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- To learn Sanskrit to improve brain functioning and enhancing the memory power
- To learn Sanskrit to develop the logic in mathematics, science & other subjects
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient Indian literature

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand basic Sanskrit language
2. Understand ancient Sanskrit literature about science & technology
3. Develop logic in students, Sanskrit being a logical language

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	3	-	-	-	2
CO2	3	3	-	-	-	2
CO3	3	3	-	-	-	2

UNIT-I

- Alphabets in Sanskrit,
- Past/Present/Future Tense,
- Simple Sentences

UNIT-II

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

UNIT-III

- Technical concepts of Engineering-Electrical, Mechanical,Architecture, Mathematics

References:

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

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

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

AC104

VALUE EDUCATION

Instruction: 3 periods per week
CIE: 40 marks
Credits: 00

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- Understand the need and importance of Values for self-development and for National development.
- Imbibe good human values and Morals
- Cultivate individual and National character.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Gain necessary Knowledge for self-development
2. Learn the importance of Human values and their application in day-to-day professional life.
3. Develop overall personality.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	-	-	-	2
CO2	2	3	-	-	-	2
CO3	2	3	-	-	-	2

UNIT I

- Values and self-development –Social values and individual attitudes.
- Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgments

UNIT II

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration.
- Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline.

UNIT III

- 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-destructive habits.
- Association and Cooperation.

UNIT IV

- Doing best for saving nature
- 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

References

1 Chakroborty, S.K., *"Values & Ethics for organizations Theory and practice*", Oxford University Press, New Delhi, 1998.

AC035

STRESS MANAGEMENT BY YOGA

Instruction: 3 periods per week
CIE: 40 marks
Credits: 0

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- Creating awareness about different types of stress and the role of yoga in the management of stress.
- Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
- Prevention of stress related health problems by yoga practice.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas.
5. Improve work performance and efficiency.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	1
CO2	-	2	-	-	-	1
CO3	-	2	-	-	-	1
CO4	-	2	-	-	-	1
CO5	-	2	-	-	-	1

UNIT I

Introduction: Definition of **Stress** – Types of stress: Acute and chronic - Stressors – Definition of **Yoga** from various sources – Types of yoga – Karma yoga, Gnana yoga, Bhakti yoga and Raja yoga – Concept of Bhagavad Geeta - Yoga versus exercise –Basics of Physiology and Psycholoy – Brain and its parts – CNS and PNS – HPA axis – Sympethetic and Para sympethetic nervous systems – Fight and Flight mechanism - Relationship between stress and yoga.

UNIT II

Ashtanga Yoga: Do`s and Don'ts in life: (i) **Yam** - Ahinsa, satya, astheya, bramhacharya and aparigraha (ii) **Niyam**-Shaucha, santosh, tapa, swadhyay, ishwarpranidhan (iii) **Asana** (iv) **Pranayama (**v) **Prathyahara (**vi) **Dharana** (vii) **Dhyana (**viii) **Samadhi** – Illustrations of eight steps of Ashtanga yoga.

UNIT III

Asana and Stress: Definition of Asana from Pathanjali – Origin of various names of asanas - Various yoga poses and their benefits for mind & body – Sequence of performing asanas: Standing, sitting, lying down on stomach, lying down on back and inverted postures – Activation of Annamayakosha – Effect on various chakras, systems and glands thereby controlling the stress levels through the practice of asanas.

UNIT IV

Pranayama and Stress: Definition of pranayama from Shankaracharya - Regularization of breathing techniques and its effects - Types of pranayama – Heat generating and cold generating techniques – Pranayama versus chakras and systems – Breathing techniques versus seasons - Anger and breathing rate – Activation of pranamayakosha – Pranayama as the bridge between mind and body – Stress control through pranayama.

UNIT V

Dhyana and Stress: Distinction between Dhyana and Dharana– Preparation for Dhyana through prathyahara and dharana – Activation of Vignanamayakosha – Types of mind: conscious, superconscious and subconscious – Activation of manomayakosha through Dhyana – Silencing the mind thereby controlling the stress levels.

References

1 '*Yogic Asanas for Group Tarining-Part-I*" : Janardan Swami YogabhyasiMandal, Nagpur

2 "*Rajayoga or Conquering the Internal Nature*" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

3 *"Light on Yoga"* by BKS Iyengar

4 "*The search for happiness and bliss*" by Swami Sarvapriyananda on you tube – https://youtu.be/xfywJTPkw7Y

5 "*Mastering the mind*" by SwaminiVimalananda on you tube - https://youtu.be/EXniWH9DMF8

AC036

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Instruction: 3 periods per week
CIE: 40 marks
Credits: 00

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

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

Course Outcomes

After the completion of this course, the students shall be able to:

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	1
CO2	-	2	-	-	-	1
CO3	-	2	-	-	-	1
CO4	-	2	-	-	-	1
CO5	-	2	-	-	-	1

UNIT I

- 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)

UNIT II

- 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.

UNIT III

- 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

References

1 Swami SwarupanandaAdvaita Ashram "*Srimad Bhagavad Gita",* (Publication Department), Kolkata

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

AC037

CONSTITUTION OF INDIA

Instruction: 3 periods per week
CIE: 40 marks
Credits: 00

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role
- Entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

Course Outcomes

After the completion of this course, the students shall be able to:

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

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	-
CO2	-	2	-	-	-	-
CO3	-	2	-	-	-	-
CO4	-	2	-	-	-	-
CO5	-	2	-	-	-	-

UNIT I

History of Making of the Indian Constitution:

- History
- Drafting Committee, (Composition & Working)

UNIT II

Philosophy of the Indian Constitution:

- Preamble
- Salient Features

UNIT III

Contours of Constitutional Rights & Duties:

- Fundamental Rights
- Right to Equality
- Right to Freedom
- Right against Exploitation
- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies
- Directive Principles of State Policy
- Fundamental Duties.

UNIT IV

- 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

UNIT V

- Local Administration:
- District's Administration head: Role and Importance,
- Municipalities: Introduction, Mayor and role of Elected Representative, CE of Municipal Corporation.
- Panchayati raj: Introduction, PRI: ZilaPanchayat.
- Elected officials and their roles, CEO ZilaPanchayat: Position and role.
- Block level: Organizational Hierarchy (Different departments),
- Village level: Role of Elected and Appointed officials,
- Importance of grass root democracy

UNIT VI

- Election Commission:
- Election Commission: Role and Functioning.
- Chief Election Commissioner and Election Commissioners.
- State Election Commission: Role and Functioning.
- Institute and Bodies for the welfare of SC/ST/OBC and women.

References

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.

AC038

PEDAGOGY STUDIES

Instruction: 3 periods per week
CIE: 40 marks
Credits: 00

Duration of SEE: 3 hours
SEE: 60 marks

Course Objectives

- To present the basic concepts of design and policies of pedagogy studies.
- To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices and familiarize various theories of learning and their connection to teaching practice.
- To create awareness about the practices followed by DFID, other agencies and other researchers and provide understanding of critical evidence gaps that guides the professional development

Course Outcomes

After the completion of this course, the students shall be able to:

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Describe the role of classroom practices, curriculum and barriers to learning.
5. Understand Research gaps and learn the future directions.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	-	-	1
CO2	-	2	-	-	-	1
CO3	-	2	-	-	-	1
CO4	-	2	-	-	-	1
CO5	-	2	-	-	-	1

UNIT I

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.

UNIT II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT III

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 material 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.

UNIT IV

Professional Development: Alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT V

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

References

1 Ackers J, Hardman F, *"Classroom Interaction in Kenyan Primary Schools, Compare*", 31 (2): 245 – 261, 2001.

2 2. Agarwal M, *"Curricular Reform in Schools: The importance of evaluation*", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.

3 Akyeampong K, "*Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)",* Country Report 1. London: DFID, 2003.

4 Akyeampong K, Lussier K, Pryor J, Westbrook J, *"Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?"*International Journal Educational Development, 33 (3): 272- 282, 2013.

5 Alexander R J, *"Culture and Pedagogy: International Comparisons in Primary Education",* Oxford and Boston: Blackwell, 2001.

6 Chavan M, Read India: *"A mass scale, rapid, learning to read campaign",* 2003

7 *www.pratham.org/images/resource%20working%20paper%202.pdf.*

EE281

MAJOR PROJECT PHASE - I

Instruction	:	20 hours per week
Duration of SEE	:	--
SEE	:	--
CIE	:	100 Marks
Credits	:	10

Course Objectives

- To identify the research problem.
- To perform literature survey.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Exposed to self-learning of various topics.
2. Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.
3. Learn to write technical reports.
4. Develop oral and written communication skills to present.
5. Defend their work in front of technically qualified audience

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	2
CO2	3	3	2	-	-	2
CO3	3	3	2	-	-	2
CO4	3	3	2	-	-	2
CO5	3	3	2	-	-	2

Guidelines

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.

- The work must be presented in front of the committee consists of Chairperson-BoS, Osmania University and Head, Supervisor & Project coordinator from the respective Department of the Institute.

- The candidate must be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Problem formulation
	10	Literature review
	10	Proposed methodology
	10	Documentation
	50	Total
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	15	Relevance of the Topic
	15	PPT Preparation
	10	Documentation
	10	Question and Answers
	50	Total

Note: The Supervisor has to assess the progress of the student regularly.

***The student has to work a minimum of 20 hours/week at Dissertation – I**

EE282

MAJOR PROJECT PHASE - II

Instruction	:	32 hours per week
Duration of SEE	:	--
SEE	:	100 Marks
CIE	:	100 Marks
Credits	:	16

Course Objectives

- To identify the research problem.
- To perform literature survey.

Course Outcomes

1. Use different experimental techniques and will be able to use different software/ computational /analytical tools.
2. Design and develop an experimental set up/ equipment/test rig.
3. Conduct tests on existing set ups/equipment's and draw logical conclusions from the results after analysing them.
4. Either work in a research environment or in an industrial environment.
5. Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.

Programme Articulation Matrix

Course outcome	Programme outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	2
CO2	3	3	2	-	-	2
CO3	3	3	2	-	-	2
CO4	3	3	2	-	-	2
CO5	3	3	2	-	-	2

Guidelines:

- It is a continuation of Major Project Phase – I started in semester - III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate must prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work must be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head of the department and Supervisor from the Institute.

- The candidate must be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in CIE : Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Problem formulation
	10	Literature review
	10	Proposed methodology
	10	Documentation
	50	Total
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	15	Relevance of the Topic
	15	PPT Preparation
	10	Documentation
	10	Question and Answers
	50	Total

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
External Examiner and Chairperson, BoS & Head of the department (All together)	**100**	Proposed methodology, Literature review, Documentation, Power Point Presentation, Quality of thesis and evaluation Innovations, application to society and Scope for future study, Viva-Voce

***The student has to work a minimum of 32 hours/week at Dissertation – II.**