



**DEPARTMENT OF ELECTRICAL ENGINEERING**

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*Scheme of Instruction  
and  
Syllabi of*

**MASTER OF ENGINEERING  
(ELECTRICAL ENGG.)**

**Power Systems**

*AICTE Model Curriculum*

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**2019 - 2020**



**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**

### **Program 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.

### **Program Outcomes**

- PO1 An ability to independently carry out research /investigation and development work to solve practical problems.
- PO2 An ability to write and present a substantial technical report/document.
- PO3 Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
- 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 EXAMINATION****M.E. - Power Systems**

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
<b>SEMESTER-I</b>								
Core-I	<b>EE 201</b>	Advanced Computer Methods in Power Systems	3	0	0	30	70	3
Core-II	<b>EE 202</b>	Advanced Synchronous Machine Theory	3	0	0	30	70	3
Program Elective-I			3	0	0	30	70	3
Program Elective-II			3	0	0	30	70	3
Mandatory Course	<b>EE 100</b>	Research Methodology in Electrical Engineering	3	0	0	30	70	3
Audit-I	<b>AC 031</b>	English for Research Paper Writing	2	0	0	30	70	0
	<b>AC 032</b>	Disaster Management						
	<b>AC 033</b>	Sanskrit for Technical Knowledge						
	<b>AC 034</b>	Value Education						
Lab	<b>EE 251</b>	Power Systems Laboratory - I	0	0	3	50	-	1.5
Seminar	<b>EE 252</b>	Seminar - I	0	0	3	50	-	1.5
<b>TOTAL</b>			<b>17</b>	<b>-</b>	<b>6</b>	<b>280</b>	<b>420</b>	<b>18</b>
<b>SEMESTER-II</b>								
Core-III	<b>EE 103</b>	Power System Stability	3	-	-	30	70	3
Core-IV	<b>EE 104</b>	Advanced Power System Protection	3	-	-	30	70	3
Program Elective-III			3	-	-	30	70	3
Program Elective-IV			3	-	-	30	70	3
Audit-II	<b>AC 035</b>	Stress Management by Yoga	2	-	-	30	70	0
	<b>AC 036</b>	Personality Development through Life Enlightenment Skills						
	<b>AC 037</b>	Constitution of India						
	<b>AC 038</b>	Pedagogy Studies						

Mandatory Course	<b>EE 070</b>	Mini Project	-	-	6	50		3
Lab	<b>EE 253</b>	Power Systems Laboratory - II	-	-	3	50	-	1.5
Seminar	<b>EE 254</b>	Seminar - II	-	-	3	50	-	1.5
<b>TOTAL</b>			<b>14</b>	<b>-</b>	<b>12</b>	<b>300</b>	<b>350</b>	<b>18</b>
<b>SEMESTER-III</b>								
Program Elective-V			3	-	-	30	70	3
Open Elective	<b>OE 941</b>	Business Analytics	3	-	-	30	70	3
	<b>OE 942</b>	Industrial Safety						
	<b>OE 943</b>	Operations Research						
	<b>OE 944</b>	Cost Management of Engineering Projects						
	<b>OE 945</b>	Composite Materials						
	<b>OE 946</b>	Waste to Energy						
	<b>EE 281</b>	Major Project Phase-I	-	-	20	50	-	10
<b>TOTAL</b>			<b>6</b>	<b>-</b>	<b>20</b>	<b>110</b>	<b>140</b>	<b>16</b>
<b>SEMESTER-IV</b>								
	<b>EE 282</b>	Major Project Phase-II	-	-	32	-	200	16
<b>GRAND TOTAL</b>						<b>1800</b>		<b>68</b>

L-Lectures  
 T-Tutorials  
 P-Practicals  
 CIE-Continuous Internal Evaluation  
 SEE-Semester End Evaluation

## COURSE INDEX

### M.E. - Power Systems (PS)

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2.	EE202	Advanced Synchronous Machine Theory	9
3.	EE203	Power System Stability	11
4.	EE204	Advanced Power System Protection	13
<b>Program Elective Subjects</b>			
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2.	EE408	Distribution System Planning and Automation	17
3.	EE409	Real Time Applications in Power Systems	19
4.	EE410	Advanced Power System Operation and Control	21
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6.	EE412	High Voltage Engineering	25
7.	EE413	Reactive Power Control and Voltage Stability	27
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<b>Audit Courses I and II</b>			
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2.	AC032	Disaster Management	53
3.	AC033	Sanskrit for Technical Knowledge	55
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6.	AC036	Personality Development Through Life Enlightenment Skills	60
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<b>Open Electives</b>			
1.	OE941	Business Analytics	66
2.	OE942	Industrial Safety	68
3.	OE943	Operations Research	70
4.	OE944	Cost Management of Engineering Projects	72
5.	OE945	Composite Materials	74
6.	OE946	Waste to Energy	76

## EE201

### ADVANCED COMPUTER METHODS IN POWER SYSTEMS

(Core PS)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>Credits</b>	<b>: 03</b>

#### **Course Objectives**

1. To understand various incidence matrices and formulation of network matrices.
2. To be familiar with various methods of triangularization and significance of optimal ordering.
3. To familiarize with bus impedance matrix preparation for a given network.
4. To understand load flow techniques and solution methods.
5. 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.

#### **Syllabus Contents**

##### **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.



## EE202

### ADVANCED SYNCHRONOUS MACHINE THEORY

(Core PS)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>Credits</b>	<b>: 03</b>

#### Course Objectives

1. Utilize the reference frame theory to model, analyze, and design AC machine drives, and understand advanced electromechanical systems
2. Carry out DC machines and drives modelling and dynamic performance analysis, and conduct DC machine drive designs and design optimization
3. Understand and use induction machine transformation theory for modelling, analysis, and design of high-performance induction machine drives
4. Understand and use synchronous machine transformation theory for modelling, analysis, and design of high-performance synchronous machine drives
5. 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

#### Syllabus Contents

##### 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.

## EE203

### POWER SYSTEMS STABILITY

(Core PS)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### **Course Objectives**

1. To gain knowledge about the dynamic mechanisms behind angle and voltage stability problems in electric power systems, including physical phenomena and modeling issues.
2. To examine the effects of excitation systems on stability.
3. To understand sub synchronous oscillations and damping schemes
4. To understand Voltage stability, means to improve it.
5. To become familiar with concepts of dynamic stability

#### **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. Design supplementary excitation systems, stabilizers for improving stability
3. Analyze sub synchronous oscillations and understand various damping schemes to reduce these oscillations
4. Understand voltage stability and methods of enhancing it.
5. Understand dynamic stability concepts using Transient Energy Function Analysis and Extended Equal Area Criterion

#### **Syllabus Contents**

##### **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. Prabha Kundur, *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 Elabadi, *Computer Methods in Power systems* - McGraw Hill., 1968.
5. John Machowski, JanuszBialek, Jim Bumby, *Power System Dynamics: Stability and Control*, Wiley.

## EE204

### ADVANCED POWER SYSTEM PROTECTION

(Core PS)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>Credits</b>	<b>: 03</b>

#### **Course Objectives**

1. To understand the necessity, operation and applications of various static relays
2. To illustrate complex relay characteristics suitable for special applications
3. To understand the various protection schemes for Generation, transmission and in distribution system
4. To be familiar with digital protection and relaying algorithms
5. To understand application of pilot protection for transmission protection

#### **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. Choose suitable CTs and PTs for fulfilling the operation of Differential relay
4. Realize the concepts and application of digital protection for various equipment in generation, transmission and distribution.
5. Apply carrier protection for transmission and distribution

#### **Syllabus Contents**

##### **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**

**Differential relays:** Generator and transformer differential protection. Digital protection scheme for Generator and transformer.

#### **UNIT IV**

**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 V**

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

#### **References**

1. Badraram 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.

## EE406

### POWER QUALITY ENGINEERING

(Program Elective – PS & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### **Course Objectives**

1. The importance of power quality, different power quality issues and their effects in power system network.
2. Different Methods of calculating the voltage sag magnitude and duration
3. Understand the types of sags and characterize the voltage sags experienced by machines
4. Know harmonics, locate sources of harmonics and mitigate harmonics
5. 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 also 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

#### **Syllabus Contents**

##### **UNIT I**

**Introduction:** Power Quality (PQ), PQ problems, Sags, Swells, Transients, Harmonics, Interruptions, Flicker, Voltage fluctuations, Notch. Transient Over voltages – 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. McGranaghan, Surya Santoso, H. Wayne Beaty, *Electrical Power Systems Quality*, Second Edition, Tata McGraw-Hill Edition.
3. C. Sankaran, *Power Quality*, CRC Press, 2002.



## EE408

### DISTRIBUTION SYSTEM PLANNING AND AUTOMATION

(Program Elective - PS)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### Course Objectives

1. To study and Analyze about distribution systems planning based on future data.
2. Understand concept of sub transmission and substation design.
3. To learn design of distribution network Primary system.
4. To calculate the electrical parameters and economical cost of secondary distribution network.
5. 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.

#### Syllabus Contents

##### 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. Turan Gonen, Electric Power Distribution System Engineering, CRC Press, Second Edition 2007
2. William Kersting, Distribution Modelling & Analysis – CRC Press – third edition - 2002
3. A.S. Pabla, Electric Power Distribution, Tata McGraw Hill, Fifth Edition, 2005.

## EE409

### REAL TIME APPLICATIONS IN POWER SYSTEMS

(Program Elective - PS)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### **Course Objectives**

1. To prepare the students to understand
2. The concept of state estimation and also the solution techniques of the state estimation problem.
3. The methodology for detection and identification of bad data from the available measurements in the Energy control centre.
4. The concepts of power system security and methods for analyzing the system security.
5. 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.

#### **Syllabus Contents**

##### **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.

## EE410

### ADVANCED POWER SYSTEM OPERATION AND CONTROL

(Program Elective - PS)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### **Course Objectives**

1. To understand the economics of power system operation using thermal units.
2. To analyze the economics of hydro-thermal units.
3. To become familiar with multi area load frequency control and application of optimal control to LFC.
4. 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.

#### **Syllabus Contents**

##### **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 changes in 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, I.J. Nagrath, Modern Power System Analysis, Tata McGraw Hill, 3Edition, 2004.

## EE411

### POWER SYSTEM DEREGULATION

(Program Elective – PS)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>Credits</b>	<b>: 03</b>

#### Course Objectives

1. Understand the new dimensions associated with operation of deregulated power systems.
2. Introduction to the power sector market, trading and bidding strategies.
3. Apply the concept of deregulation and ATC.
4. Understand the electricity power business and technical issues in a deregulated power system in both Indian and world scenario.
5. 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.

#### Syllabus Contents

##### 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, Bidding 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, JaapE.Daalder, ‘Operation of Restructured Power System’ Kluwer Academic Publisher – 2001
2. Mohammad Shahidehpour, and Muwaffaqalomoush, - “Restructured Electrical Power systems” Marcel Dekker, Inc. 2001
3. Loi Lei Lai; “Power system Restructuring and Deregulation”, John Wiley & Sons Ltd., England.



**EE412**

## **HIGH VOLTAGE ENGINEERING**

(Program Elective – PS)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

### **Course Objectives**

1. To understand the concepts of conduction and breakdown of gaseous.
2. To understand the conduction and breakdown in solids and liquids.
3. To understand the generation of high dc voltages and production of high frequency ac voltages.
4. To study the various measuring techniques of high voltages and currents.
5. To study the high voltage testing of insulators, circuit breakers and cables.

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

1. Analyze the ionization process and current growth in gases.
2. Understand various mechanisms of break down in solids and liquids.
3. Design the circuits used in generation of high voltage dc, ac, switching surges and impulse currents.
4. Implement the measuring techniques for high dc, ac and impulse voltages and currents.
5. Perform tests on high voltage equipment.

### **Syllabus Contents**

#### **UNIT I**

**Conduction and Breakdown of Gaseous Insulating Materials:** Ionization processes and current growth -- Townsend's criterion for breakdown - Breakdown in electronegative gases - Time lags for breakdown - Paschen's law - Corona discharges - Breakdown in non-uniform fields - Practical considerations for selecting gases for insulation purposes.

#### **UNIT II**

**Conduction and Breakdown in Liquid and Solid Dielectrics:** Various mechanisms of breakdown in liquid dielectrics - Liquid dielectrics used in practice- Various processes - Breakdown in solid dielectrics- Solid dielectrics used in practice.

#### **UNIT III**

**Generation of High Voltages and Currents:** Generation of high D.C voltages using voltage multiplier circuits - Van de Graff generator. Generation of high alternating voltages using cascade transformers- Production of high frequency A.C high voltages - Standard impulse wave shapes - Marx circuit - Generation of switching surges - Impulse current generation - Tripping and control of impulse generators.

#### **UNIT IV**

**Measurement of High Voltages and Currents:** High D.C voltage measurement techniques - Methods of measurement for power frequency A.C voltages - Sphere gap measurement technique - Potential divider or impulse voltage measurements Measurement of high D.C, A.C and Impulse currents - Use of CRC for impulse voltage and current measurements.

#### **UNIT V**

**High Voltage Testing:** Tests on insulators - testing on bushings - Testing of isolators and circuit breakers -Cable testing of transformers Surge diverter testing – Radio interference measurement - Use of I.S.S. for testing.

#### **References**

1. M.S. Naidu and V. Kamaraju, *High Voltage Engineering*, Tata McGraw Hill, 1982.
2. E. Kuffel and M. Abdullah, *High Voltage Engineering*, Pergamon Press, 1970.

## EE413

### REACTIVE POWER CONTROL AND VOLTAGE STABILITY

(Program Elective – PS)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### *Course Objectives*

1. *To understand the relation between reactive power and voltage stability.*
2. *To analyze the reasons for voltage collapse phenomenon.*
3. *To understand various ways of assessing voltage stability and methods of improving voltage stability.*
4. *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.*

#### *Syllabus Contents*

##### **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 - AbhijitChakrabarti, 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.

## EE414

### NEURAL NETWORKS AND DEEP LEARNING

(Program Elective – PS)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### **Course Objectives**

1. To introduce the Neural & fuzzy intelligence
2. To study the different models in ANN and their applications
3. To familiarize different learning concepts and algorithms of Neural Networks
4. To familiarize the fundamentals of Fuzzy Logic required to apply Fuzzy Logic in control, pattern recognition and Planning and Diagnosis.
5. To 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.

#### **Syllabus Contents**

##### **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.

## EE430

### POWER ELECTRONIC APPLICATIONS TO POWER SYSTEMS

(Program Elective – Common to PS, IDC & PES)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>Credits</b>	<b>: 03</b>

#### Course Objectives

1. To understand the issues involved in existing Power Transmission system
2. To be familiar with the Techniques to overcome the problems associated with AC Power Transmission system
3. 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.

#### Syllabus Contents

##### 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 circuit representation 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 Angeles Camacho 'FACTS –Modeling and simulation in Power Networks' John Wiley & Sons, 2002.



## EE431

### RENEWABLE ENERGY SOURCES

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### Course Objectives

1. To understand the concepts and Importance of renewable energy sources such as solar, wind, biomass, tidal power.
2. To make the students understand the advantages and disadvantages of different renewable energy sources
3. 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

#### 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 H<sub>2</sub> / O<sub>2</sub> 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.

## EE432

### ELECTRIC AND HYBRID ELECTRICAL VEHICLES

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### Course Objectives

1. To understand the basics of electric and hybrid electric vehicles and their working
2. To understand the basics of batteries and their role for electric/hybrid vehicle applications
3. To obtain the knowledge of various types of electric/hybrid vehicles
4. 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.

#### Syllabus Contents

##### 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, Uimin Gao 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. Abul Masrur, David Wenzhong Gao - A John Wiley & Sons, Ltd., - 2011.
5. Electric & Hybrid Vehicles – Design Fundamentals-Iqbal Hussain, Second Edition, 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 and Mansoor Alam - 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.

## EE433

### MODERN CONTROL THEORY

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### **Course Objectives**

1. To provide the fundamentals required to model a control system in state space and check its controllability and observability.
2. To educate the students about non-linear systems behavior and the methods to determine their stability.
3. To make then students thorough with Liapunov stability analysis.
4. To familiarize the students with the concept of optimal control and how to determine optimum for functional using calculus of variations.
5. 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.

#### **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 theory An introduction
3. Karl J Astrom Bjronwihenmark, *Adaptive control* second edition – Pearson education.

## EE434

### RELIABILITY ENGINEERING

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### **Course Objectives**

1. To comprehend the basics of probability distributions & reliability models.
2. To model systems with series-parallel block diagrams and state-space diagrams and to understand time dependent and limiting state probabilities using Markov models.
3. To understand multi-mode failures of electrical & electronic circuits and their effect on reliability & availability.
4. 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

#### **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 nonidentical 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 distributor 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.



## EE435

### OPTIMIZATION METHODS

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours

#### Course Objectives

1. To understand the concepts of single variable and multivariable optimization with and without constraints
2. To make the students understand about linear and nonlinear optimization problems.
3. 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

#### 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**

***Evolutionary computations:*** Introduction – Genetic algorithms – Terminologies and operations of GA – Advanced operators and techniques in GA – Introduction to particle swarm optimization and Ant colony optimization.

#### **UNIT V**

***Advanced topics in optimization:*** Fast Multi-swarm Optimization for Dynamic Optimization, Reliability-Based Optimization Using Evolutionary Algorithms, Ant Colony Optimization for Mixed-Variable Optimization Problems, Bacterial Foraging Global Optimization Algorithm.

#### ***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 – Springer – 2013.
5. Reliability-Based Optimization Using Evolutionary Algorithms: IEEE transactions on evolutionary computation, vol. 13, no. 5, October 2009.
6. Ant Colony Optimization for Mixed-Variable Optimization Problems: IEEE Transactions on evolutionary computation, vol. 18, no. 4, august 2014.

## EE436

### ADVANCED MICROPROCESSORS

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### Course Objectives

1. To understand the interfacing circuits for various peripheral applications
2. To illustrate the architecture of processor of 8086
3. To introduce to the programming and interfacing techniques of 8086
4. Apply knowledge of soft skill and other resources to design automated system with programming module
5. 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

#### 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.

**EE437**

## **PROGRAMMABLE LOGIC CONTROLLERS**

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

### **Course Objectives**

1. To provide the knowledge of different components used in PLCs such as processor, input/output devices and program monitors
2. To make the students thorough with ladder programming of PLC.
3. To train them how to use timer, counter, register, arithmetic and different conversion systems.
4. To give awareness about application of different PLC features in Process control industry and different data handling functions of PLC.

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

1. Understand different components of PLC.
2. Construct ladder diagrams for different industry applications.
3. Deal with applications like timer/counter, registers etc.
4. Understand the utility of different features of PLC in process industry.
5. Use data handling function in PLC programming.

### **Syllabus Contents**

#### **UNIT I**

**PLC Basics:** Definition and History of PLC - PLC advantages and disadvantages - Over all PLC Systems - CPUs and Program Monitors - PLC input and output models - Printing PLC Information- Programming Procedures – Programming Equipment - Programming Formats- Proper Construction of PLC Diagrams – Devices to which PLC input and output modules are connected - Input on/off switching devices - Input analog devices - Output analog on/off devices and output analog devices.

#### **UNIT II**

**Basic PLC Programming:** Programming on/off inputs to produce on/off outputs - PLC input instructions - Outputs - Operational procedures - Contact and coil input/output programming examples - Relation of digital gate logic contact / coil logic - PLC programming and conversion examples - Creating ladder diagrams from process control descriptions - Sequence listings - Large process ladder diagram constructions.

#### **UNIT III**

**Basic PLC Functions:** General Characteristics of Registers - Module addressing - Holding registers - Input registers - output registers - PLC timer functions – examples of timer functions. Industrial applications - PLC counter functions.

#### **UNIT IV**

**Intermediate Functions:** PLC Arithmetic functions - PLC additions and subtractions - The PLC repetitive clock - PLC Multiplications, Division and Square Root – PLC trigonometric and log functions - Other PLC arithmetic functions - PLC number comparison functions. PLC basic comparison functions and applications – Numbering systems and number conversion functions - PLC conversion between decimal and BCD-Hexadecimals numbering systems.

#### **UNIT V**

**Data Handling Functions:** The PLC skip and master control relay functions – Jump functions - Jump with non return - Jump with return. PLC data move Systems – The PLC functions and applications. PLC functions working with bits - PLC digital bit functions and applications - PLC sequence functions - PLC matrix functions.

#### **References**

1. John W. Weff, Ronald A. Reis, *Programmable Logic Controllers*, Prentice Hall of India Private Limited, Fifth edition, 2003.

## EE438

### DIGITAL SIGNAL PROCESSING

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### Course objectives

1. To gain knowledge about discrete time signal and systems; their representation, operations and properties.
2. To understand the importance of frequency domain representation of discrete time signals and calculating DTFT, DFT and FFT.
3. To learn to represent discrete time signals and systems in Z-domain and finding solution of difference equations using z-transform.
4. To design IIR and FIR filters.
5. 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.

#### 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 & Schaffter, Digital Signal Processing, PHI Pub.
4. S.K. Mitra, Digital Signal Processing, TMH, 1996.



## EE439

### SMART GRID TECHNOLOGY

(Program Elective – Common to PS, IDC & PES)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### Course Objectives

1. To introduce the concept of smart grid, difference between conventional grid and smart grid
2. To introduce the main components of smart grid
3. To introduce microgrids and grid integration issues of renewable energy sources
4. To introduce the load frequency control concepts in microgrid

#### Course Outcomes

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

1. Understand advantages of smart grid system.
2. Know the key challenges for smart grid.
3. Understand the importance of D.C. sources, loads and D.C. grid.
4. Analyze the impact of electric vehicles on the grid and grid integration issues of renewable energy sources.
5. Understand the control methodologies in operation of smart power systems.

#### Syllabus Contents

##### UNIT I

**Introduction to Smart Grid:** Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions-comparison of Power Grid and Smart Grid-New Technologies for Smart Grid – Advantages – Present development and International policies in Smart Grid, Indian Smart Grid. Key Challenges for Smart Grid. Components and Architecture of Smart Grid-Description.

##### 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 equipment and appliances with DC-Data centers and information technology loads – Future neighbourhood- Potential future work and research.

##### UNIT III

**Smart Grid Architecture, Smart Grid Communications and Measurement Technology:** Communication and Measurement – Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area measurement System (WAMS).

#### **UNIT IV**

***Renewable Energy and Storage:*** Introduction to Renewable Energy Technologies Micro Grids-Storage Technologies-Electric Vehicles and plug-in hybrids Environmental impact and Climate Change-Economic Issues. Grid integration issues of renewable energy sources.

#### **UNIT V**

***Smart Power Grid System Control:*** Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System, Reactive Power Control in Smart Grid.

#### ***References***

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013.
2. A.G. Phadke and J.S. Thorp, “Synchronized Phasor Measurements and their Application”, Springer Edition, 2010.
3. Iqbal Hussein, “Electric and Hybrid Vehicle: Design fundamentals”, CRC Press, 2003.
4. Gilbert M Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.
5. Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed & Efficient Energy”, Academic Press, 2012.
6. Jean Claude Sabonnadiere, Nouredine Hadjsaid, “Smart Grids”. Wiley-ISTE, IEEE Press, May 2012.

## AC 031

### ENGLISH FOR RESEARCH PAPER WRITING

(Audit course)

<i>Instruction</i>	: 3 hours per week
<i>Duration of SEE</i>	: 3 Hours
<i>SEE</i>	: 70 Marks
<i>CIE</i>	: 30 Marks
<i>Credits</i>	: 00

#### *Course Objectives*

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

#### *Course Outcomes*

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

1. Plan and prepare paragraphs, avoiding ambiguity
2. Writing of abstracts, paraphrasing and plagiarism
3. Provide critical and thorough review of literature, discussions and conclusions
4. exhibit key skills for writing titles, introduction, abstract.
5. Able to show key and necessary skills for paper writing, phrases, results.

#### *Syllabus Contents*

##### **UNIT I**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

##### **UNIT II**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

##### **UNIT III**

Review of the Literature, Methods, Results, Discussion, Conclusions. The Final Check.

##### **UNIT IV**

Key skills needed when writing a Title, key skills needed when writing an Abstract, key skills needed when writing an Introduction, skills needed when writing a Review of the Literature.

## **UNIT V**

Skills needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills needed when writing the Conclusions. Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

### ***References***

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

**AC 032**

## **DISASTER MANAGEMENT**

(Audit course)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>Credits</b>	<b>: 00</b>

### **Course Objectives**

1. To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
2. To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
3. 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.

### **Syllabus Contents**

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

**AC 033**

**SANSKRIT FOR TECHNICAL KNOWLEDGE**

(Audit course)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>Credits</b>	<b>: 00</b>

**Course Objectives**

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. To learn Sanskrit to improve brain functioning and enhancing the memory power
3. To learn Sanskrit to develop the logic in mathematics, science & other subjects
4. 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

**Syllabus Contents**

**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.

**AC 034**

**VALUE EDUCATION**

(Audit course)

<i>Instruction</i>	: 3 hours per week
<i>Duration of SEE</i>	: 3 Hours
<i>SEE</i>	: 70 Marks
<i>CIE</i>	: 30 Marks
<i>Credits</i>	: 00

**Course Objectives**

1. Understand the need and importance of Values for self-development and for National development.
2. Imbibe good human values and Morals
3. 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.

**Syllabus Contents**

**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.

**AC 035**

## **STRESS MANAGEMENT BY YOGA**

(Audit course)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>Credits</b>	<b>: 00</b>

### **Course Objectives**

1. *Creating awareness about different types of stress and the role of yoga in the management of stress.*
2. *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
3. *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.*

### **Syllabus Contents**

#### **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 Psychology – Brain and its parts – CNS and PNS – HPA axis – Sympathetic and Para sympathetic 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 Training-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>

**AC 036**

**PERSONALITY DEVELOPMENT THROUGH LIFE  
ENLIGHTENMENT SKILLS**

(Audit course)

<i>Instruction</i>	: 3 hours per week
<i>Duration of SEE</i>	: 3 Hours
<i>SEE</i>	: 70 Marks
<i>CIE</i>	: 30 Marks
<i>Credits</i>	: 00

**Objectives**

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

**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.

**Syllabus Contents**

**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 Swarupananda Advaita Ashram “*Srimad Bhagavad Gita*”, (Publication Department), Kolkata
- 2 P.Gopinath, “*Bhartrihari’s Three Satakam (Niti-sringar-vairagya)*”, Rashtriya Sanskrit Sansthanam, New Delhi

**AC 037**

## **CONSTITUTION OF INDIA**

(Audit course)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>Credits</b>	<b>: 00</b>

### **Course Objectives**

1. *Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective*
2. *To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role*
3. *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.*

### **Syllabus Contents**

#### **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: Zila Panchayat.
- Elected officials and their roles, CEO Zila Panchayat: 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.

**AC 038**

## **PEDAGOGY STUDIES**

(Audit course)

<b>Instruction</b>	<b>: 3 hours per week</b>
<b>Duration of SEE</b>	<b>: 3 Hours</b>
<b>SEE</b>	<b>: 70 Marks</b>
<b>CIE</b>	<b>: 30 Marks</b>
<b>Credits</b>	<b>: 00</b>

### **Course Objectives**

1. *To present the basic concepts of design and policies of pedagogy studies.*
2. *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.*
3. *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.*

### **Syllabus Contents**

#### **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 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](http://www.pratham.org/images/resource%20working%20paper%202.pdf).

**OE941**

## **BUSINESS ANALYTICS**

(Open Elective)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

### **Course Objectives**

1. To understand the role of business analytics within an organization.
2. To analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. 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.

### **Syllabus Contents**

#### **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/>

**OE942**

## **INDUSTRIAL SAFETY**

(Open Elective)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

### **Course Objectives**

1. To understand industrial safety and remember features of factory act 1948.
2. Analyze maintenance tools, corrosion preventive measures and fault causes.
3. 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.

### **Syllabus Contents**

#### **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.

**OE943**

## **OPERATIONS RESEARCH**

(Open Elective)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

### **Course Objectives**

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:

1. apply the dynamic programming to solve problems of discrete and continuous variables
2. apply the concept of non-linear programming
3. carry out sensitivity analysis
4. understand deterministic and probabilistic inventory control models.
5. model the real-world problem and simulate it.

### **Syllabus Contents**

#### **Unit I**

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

#### **Unit II**

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

#### **Unit III**

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

#### **Unit IV**

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

#### **Unit V**

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

***References***

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

## OE944

### COST MANAGEMENT OF ENGINEERING PROJECTS

(Open Elective)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

#### Course Objectives

1. Introduce the concepts of cost management, inventory valuation, decision making
2. Fundamentals of cost overruns, project execution and technical activities
3. 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

#### 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.

**OE945**

## **COMPOSITE MATERIALS**

(Open Elective)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

### **Course Objectives**

1. To understand the fundamentals of composite materials and the role of matrix and reinforcement.
2. To know the principles of manufacturing composite
3. To understand the strength and failure criteria of lamina and laminate.

### **Course Outcomes**

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

1. Define a composite, identify the matrix and reinforcement and highlighting the features and application of different composite materials.
2. Classify composites, illustrate the mechanical behaviour of composites and predict properties using micromechanics principles.
3. Illustrate the manufacturing of metal matrix composites and outline the properties and applications.
4. Illustrate the manufacturing of Polymer matrix composites and outline the properties and applications.
5. Apply various failure criteria to assess the strength of lamina and laminates.

### **Syllabus Contents**

#### **UNIT I**

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

#### **UNIT II**

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

#### **UNIT III**

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

#### **UNIT IV**

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

#### **UNIT V**

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

#### **References**

1. Material Science and Technology- Vol 13- Composites by R.W. Cahn-VCH, West Germany.
2. Materials Science and Engineering, An Introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Composite Materials- K. K. Chwala.
4. Composite Materials Science and Applications-Deborah D.L. Chung.
5. Composite Materials Design and Applications-Danial Gay, Suong V. Hoa and Stwphen W. Tsai.

**OE946**

## **WASTE TO ENERGY**

(Open Elective)

<i>Instruction</i>	: 3 hours per week
<i>CIE</i>	: 30 Marks
<i>SEE</i>	: 70 Marks
<i>Duration of SEE</i>	: 3 Hours
<i>Credits</i>	: 03

### **Course Objectives**

1. To know the various forms of waste
2. To understand the processes of Biomass Pyrolysis.
3. To learn the technique of Biomass Combustion.

### **Course Outcomes**

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

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

### **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 program 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.

## EE 252

### SEMINAR – I

<i>Instruction</i>	: 3 hours per week
<i>Duration of SEE</i>	: --
<i>SEE</i>	: --
<i>CIE</i>	: 50 Marks
<i>Credits</i>	: 1.5

#### **Course Objectives**

1. Identify appropriate topic of relevance.
2. Update literature on technical articles of selected topic and develop comprehension.
3. Prepare a technical report.
4. 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.

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.

<b>Guidelines for awarding marks</b>		
<b>S. No.</b>	<b>Description</b>	<b>Max. Marks</b>
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

**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.

## EE 254

### SEMINAR – II

<i>Instruction</i>	: 3 hours per week
<i>Duration of SEE</i>	: --
<i>SEE</i>	: --
<i>CIE</i>	: 50 Marks
<i>Credits</i>	: 1.5

#### **Course Objectives**

1. Identify appropriate topic of relevance.
2. Update literature on technical articles of selected topic and develop comprehension.
3. Prepare a technical report.
4. 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.

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.



<b>Guidelines for awarding marks</b>		
<b>S. No.</b>	<b>Description</b>	<b>Max. Marks</b>
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

**Note:**

5. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
6. **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.
7. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
8. 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.

## EE 070

### MINI PROJECT

<b>Instruction</b>	<b>: 6 hours per week</b>
<b>Duration of SEE</b>	<b>: --</b>
<b>SEE</b>	<b>: --</b>
<b>CIE</b>	<b>: 50 Marks</b>
<b>Credits</b>	<b>: 1.5</b>

#### **Course Objectives**

1. To review available literature and formulate structural engineering problems
2. 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 program 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

**Departmental committee: Supervisor and a minimum of two faculty members**

<b>Guidelines for awarding marks in CIE (Continuous Internal Evaluation):</b>		
<b>Max. Marks: 50</b>		
<b>Evaluation by</b>	<b>Max. Marks</b>	<b>Evaluation Criteria / Parameter</b>
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

## EE 281

### MAJOR PROJECT PHASE - I

<i>Instruction</i>	: 20 hours per week
<i>Duration of SEE</i>	: --
<i>SEE</i>	: --
<i>CIE</i>	: 100 Marks
<i>Credits</i>	: 10

#### *Course Objectives*

1. To identify the research problem.
2. 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

#### *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 has to 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 has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

<b>Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100</b>		
<b>Evaluation by</b>	<b>Max. Marks</b>	<b>Evaluation Criteria / Parameter</b>
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

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

## EE 282

### MAJOR PROJECT PHASE - II

<i>Instruction</i>	: 32 hours per week
<i>Duration of SEE</i>	: --
<i>SEE</i>	: --
<i>CIE</i>	: 200 Marks
<i>Credits</i>	: 16

#### **Course Objectives**

1. To identify the research problem.
2. To perform literature survey.

#### **Course Outcomes**

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

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.

#### **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 has to 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 has to 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 has to be in regular contact with his/her Supervisor / Co- Supervisor

<b>Guidelines for awarding marks in SEE (Semester End Examination):</b> <b>Max. Marks: 200</b>		
<b>Evaluation by</b>	<b>Max. Marks</b>	<b>Evaluation Criteria / Parameter</b>
External Examiner and Chairperson, BoS & Head of the department (All together)	40	Power Point Presentation
	90	Quality of thesis and evaluation
	40	Innovations, application to society and Scope for future study
	30	Viva-Voce