Shivaji University, Kolhaour
Faculty of Engineering and Technology
Electrical Engineering
Structure for BE Electrical

Semester VII

Sr. No	Category	Course Title	L	T	P	Contact Hours	Marks			
							Theory	T W	POE	Total
1	EE	Industrial Training		1		1		50		50
2	ES	Economics for Engineers	2			2	50			50
3	EE	Advanced Switchgear and Protection	4		2	6	100	25	50	175
4		Power Quality and Harmonics	3	1		4	100	25		125
5	EE	Computer Methods in Power Systems	4		2	6	100	25	25	150
6	EE	Elective I	4			4	100			100
7	EE	Seminar			2	2		50		50
8	EE	Project Phase I			4	4		50	50	100
			17	2	10	29	450	225	125	800

Elective I
1. FACTS
2. Signal Processing For Electrical Engg.
3. Industrial Automation and SCADA
4. Restructured Power Systems

Semester VIII

Sr. No	Category	Course Title	L	T	P	Contact Hours	Marks			
							Theory	T W	POE	Total
1	ES	Law for Engineers	2			2	50			50
2	EE	HVDC Systems	4		2	6	100		50	150
3	EE	EHVAC	4			4	100			100
4	EE	Electrical Generation and Utilization	4	2		6	100	50		150
5	EE	Elective II	4		2	6	100	50		150
6	EE	Project Phase II			6	6		100	100	200
			18	2	10	30	450	200	150	800

Elective II
1. Embedded Systems
2. High Voltage Engineering
3. Advanced Relaying
4. Electrical maintenance and electrical energy audit.

SEMESTER I

1. INDUSTRIAL TRAINING

Assessment of Industrial training report will be done by the faculty incharge by conducting presentations of the students and report and presentation should consists of 1. Brief overview of the industry, 2. Product Details, 3. Production Practices, 4. Type of electric supply and its utilization, 5. Details of Electric tariff, 6. Practices used for electric safety and maintenance,. 6. Energy auditing

2. ECONOMICS FOR ENGINEERS

Teaching Scheme: Examination Scheme:
Lectures:2 Hours /week Paper: 50 Marks

Objectives:

The objective of this course is to familiarize the prospective engineers with elementary principles of economics. It also deals with acquainting the students with standard concepts and tools that they are likely to find useful in their profession when employed in the firm/industry/corporation in public or private sector. It also seeks to create and awareness about the status of the current economic parameters /indicators/ policy debates. All of this is a part of the quest to help the students imbibe soft skills that will enhance their employability.

1*:* **Basic Principles and Methodology of Economics**. Demand/Supply – elasticity – Government Policies and Application.Theory of the Firm and Market Structure. Basic Macroeconomic Concepts (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes *(12 Lectures)*

2*:* **Public Sector Economics** –Welfare, Externalities, Labour Market.Components of Monetary and Financial System, Central Bank –Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy Tools & their impact on the economy – Inflation and Phillips Curve. *(11 Lectures)*

3*:* **Elements of Business/Managerial Economics and forms of organizations**. Cost & Cost Control –Techniques, Types of Costs, Budgets, Break even Analysis, Capital Budgeting, Application of Linear Programming. Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money. Business Forecasting – Elementary techniques. Statements – Cash flow, Financial. Case Study Method. *(11 Lectures)*

4*:* **Indian economy Brief overview of post independence period** – plans. Post reform Growth, Structure of productive activity. Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization. Employment–Informal, Organized, Unorganized, Public, Private. Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors. *(11 Lectures)*

Text/Reference Books:

1. Pravin Kumar(2015), Fundamentals of Engineering Economics, Wiley Precise Text book Series
2. Mankiw Gregory N.(2002), *Principles of Economics,* Thompson Asia
3. V. Mote, S. Paul, G. Gupta(2004), *Managerial Economics,* Tata McGraw Hill
4. Misra, S.K. and Puri (2009), *Indian Economy,* Himalaya
5. Pareek Saroj (2003), *Textbook of Business Economics,* Sunrise Publishers

3. ADVANCED SWITCHGEAR AND PROTECTION

Teaching Scheme:	Examination Scheme:
Lectures:4 Hours /week	Paper: 100 Marks
Practical: 2 Hours/week	T.W.: 25 Marks
	POE: 50 Marks

1.Circuit Breakers: a)Voltage -current characteristics of arc, Principles of DC and AC arc interruption, high resistance and current zero interruption, arc voltage, Transient Restriking Voltage (TRV), Recovery voltage, RRRV, current chopping, resistance switching, capacitive current interruption. (6Hrs)

b) Classification of circuit breakers, brief study of construction and working of bulk oil and minimum oil CB, Air break and Air Blast CB, SF6 and Vacuum CB, HVDC breakers, ratings of CB and testing of CB (6Hrs)

c) Fuse: Rewirable and HRSC fuse, fuse characteristics, application and selection of fuse. (6Hrs)

2. Relays: Selectivity, sensitivity, reliability and speed of operation of a relay, CT burden calculation, attracted armature, balanced beam, moving coil relays, theory and construction of induction disc and induction cup relays, numerical relays, microprocessor based relaying. (6Hrs)

3.Over current Protection : Plug setting, time setting, radial feeder and ring mains protection, earth fault and phase fault, Directional relay, and microprocessor based o/c relay. (4Hrs)

4. Differential Relays: circulating current and opposed voltage principles, percentage differential relay, line protection, carrier aided protection scheme.
(4Hrs)

5. Transformer protection: Problems associated with percentage differential protection, harmonic restraint and harmonic blocking schemes, restricted earth fault protection, Buchholz relay for incipient faults.
(4Hrs)

6. Generator protection: stator earth fault, phase fault, stator current unbalance (NPS) protection, Rotor overheating, earth fault protection, excitation failure and protection against motoring, generator-transformer unit protection. (4Hrs)

Distance protection: Impedance, reactance and admittance characteristics, relay settings for 3-zone protection, out of step blocking scheme, blinder relay, numerical relays for transmission line protection, microprocessor based impedance, reactance and mho relays. (4Hrs)

Over voltage Protection: Causes of over voltages, surge arrestors and absorbers, metal oxide (ZnO) arrestors, insulation co-ordination in a power system. (4Hrs)

List of Experiments:

1) Drawing sheet showing construction of MOCB, ABCB, SF6 CB and Vacuum CB.
2) Drawing sheet for Generator and transformer protection schemes.
3) Study of construction and working of induction disc type relays.
4) Plotting of I α t characteristics of an IDMT over current or E/F relay.
5) Experimental study of working of electromechanical overvoltage relay.
6) Experimental study of working of a Directional over current relay.
7) Experimental realization of microprocessor based over current relay.
8) Experimental realization of microprocessor based over-voltage/Under Voltage relay.
9) Experimental realization of microprocessor based impedance relay.
10) Experimental realization of microprocessor based Directional over current relay.

Textbooks and References :

1) Power System Protection and Switchgear: B.Ram and B.N. Vishwakarma
2) Fundamentals of Power System Protection : Y. G. Paithankar , S. R. Bhide
3) Switchgear and Protection: Sunil.S. Rao, Khanna Publications
4) Digital Protection: L.P.Singh
5) Switchgear and Protection: M.V. Deshpande

4. POWER QUALITY AND HARMONICS

Lecture: 3 period/week **Theory: 100 marks**
TUT: 1 period/week **T.W: 25 marks**

Unit I **08 hours**

Introduction to Power Quality: Desired feature of Electrical Power Supply, Power Quality related issues in distribution systems, loads and theirs characteristics, electromagnetic phenomena, voltage sags/swells, waveform distortions, unbalance, flicker, notches, unbalance and load balancing.

Unit II **08 hours**

Fundamental of Harmonics: causes for generation of harmonics, effect of harmonic on systems, types and characterization of Harmonics, THDs, influence on power factor, interference with communication network and harmonic indices.

Unit III **09 hours**

Harmonics Suppression Filters: Shunt Passive Filters, Design Considerations and case studies, Voltage / Current Source active filters, types: shunt, series and Hybrid Filter, their characteristics and comparison.

UNIT IV **08 hours**

Mitigation of Voltage Sag and interruptions: End user issues, UPS systems, Ferro resonant Transformers, Super Conducting Storage Devices, Dynamic Voltage Restorer and Application of DSTATCOM.

UNIT V **07 hours**

Harmonic Measurement: Instrumentation techniques, Analog and Digital Methods,presentation of Harmonic data and Interruption, case studies, Harmonic Standard and future trends.

UNIT VI **08 hours**

Power Quality Monitoring: Power Quality Analyzer, Acceptability of Power Supply- tolerance envelops of CBEMA and ITIC, reliability indices, typical wiring and grounding problems, grounding practices and use of signal reference grid.

Textbook

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, *'Electrical Power Systems Quality'* McGraw Hill, 2003.
2. Dr. Mahesh Kumar, IIT Chennai, *Power Quality in Distribution Systems*.
3. A. Ghosh and G. Ledwich, *Power Quality Enhancement using Custom Power Devices*. Boston, MA: Kluwer, 2002.

References:

1. J. Arrillaga, N.R. Watson, S. Chen, *'Power System Quality Assessment'*, (New York: Wiley, 1999).
2. G.T. Heydt, *'Electric Power Quality*', 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994).

3. George J. Wakileh, *"Power System Harmonics* - Fundamentals, Analysis & filter Design" Springer.
4. M.H.J Bollen, '*Understanding Power Quality Problems*: Voltage Sags and Interruptions', (New York: IEEE Press, 1999).
5. Angelo Baggini, *Handbook on Power Quality*, John Wiley & Sons, New Jersey, USA, 2008.

5. COMPUTER METHODS IN POWER SYSTEMS.

Teaching Scheme		**Examination Scheme**	
Lectures:	4 Hr/Week	Theory:	100
Tutorial:	--	Term work:	25
Practical:	2 Hr/Week	POE:	25
Total:	6 Hr/Week	Total:	150

Unit 1:- Network Topology **8 Hrs**

Introduction, Basic Principles in Power System Analysis, Elementary Graph Theory, Incidence Matrices, Connectivity, Primitive Network, Singular Transformation, Non-singular Transformation, Numerical Treatment Expected

Unit 2:- Computer Solution Methods Using the Admittance Matrix **6 Hrs**

Introduction, Formation of Y_{BUS} by inspection- Modeling of transmission lines, Modeling of transformer, Modeling of shunt elements, Modeling of loads, Modeling of generator internal impedance, Step by Step Algorithm for Formation of Y_{BUS}, Numerical treatment expected

Unit 3:- Computer Solution Methods Using the Impedance Matrix **8 Hrs**

Impedance matrix in shunt fault computations, impedance matrix algorithm, adding a radial impedance to the reference node, adding a radial branch to a new node, closing a loop to the reference, closing a loop not involving the reference, adding a mutually coupled radial element, adding a group of mutually coupled lines, comparison of admittance and impedance matrix techniques, Numerical treatment expected

Unit 4:- Computer techniques for Power flow analysis **8 Hrs**

Introduction, Impact of computers, orientation of engineering problems to computers, Power Flow equation, Classification of buses, Operating constraints, Data for load flow, Formulation of load flow problem, solution technique using bus admittance matrix in the bus frame of reference, solution technique using bus impedance matrix in the bus frame of reference, Numericals expected to be solved up to first iteration.

Unit 5:- Simultaneous Faults **10 Hrs**

Simultaneous Faults by Two-Port Network Theory- Two port networks, interconnection of two port networks, simultaneous fault connection of sequence networks, series-series connection (Z-type faults), Parallel -parallel connection (Y-type faults), series-parallel connection (H-type faults), Simultaneous faults by matrix transformations- constraint matrix for Z-type faults, constraint matrix for Y-type and H-type faults, Numerical treatment expected

Unit 6:- Analytical Simplifications **8 Hrs**

Two Component Method

Shunt Faults- SLG Fault, LL Fault, DLG Fault, Three phase fault, Shunt Faults- 2LO Fault, 1LO Fault, Change in symmetry with two component calculations- phase shifting transformer relations, SLG faults with arbitrary symmetry, DLG faults with arbitrary symmetry, series faults with arbitrary symmetry.

Term-work:

Minimum 8 experiments based on analysis using Computer Software such as MATLAB/ Simulink, ETAP etc.

Reference Book

1. Analysis of Faulted Power Systems by Paul.M. Anderson, IEEE Press Power Systems Engineering Series
2. Circuits Analysis of A,C. power system VOL-II by Edith Clarke
3. Introduction to Matrices & Power System by R.Bruce Shipley
4. Computer methods in Power System Analysis by Stagg G.W. & E.L. Abiad
5. Advanced Power System Analysis & Dynamics by L.P. Singh, New Age International Publishers, Fifth Edition
6. Power System Analysis by Grainger, J.J. and Stevenson, W. D. Tata McGraw-Hill Edition
7. Computer Techniques and Models in Power Systems 2nd Edition, 2014 by K. Uma Rao, I.K. International Publishing House Pvt Ltd

6. ELECTIVES I

FACTS

Teaching scheme:

Lectures: 4 hrs / week **Theory: 100 Marks**

UNIT I **07 Hours**

1. **Introduction to FACTS**: Need of transmission interconnection, power flow in ac system, loading limit, importance of FACTS, transmission network, introduction to basic types of FACTS controller, comparison of HVDC and FACTS.

UNIT II **0 8 Hours**

2. **Statics shunt compensators ,SVC** : Objectives of the shunt Compensation, Static VAR compensators (TSC, TCR, FC-TCR, TSC, TCR), switching transient in TSC, functional control Scheme for FC-TCR and TSC-TCR.

UNIT III **10 Hours**

3. **Static Synchronous compensator STATCOM**: basic principal and control scheme for STATCOM, hybrid var generation, comparison between STATCOM and SVC.

UNIT IV **08 Hours**

4. **Static Series compensators:** objectives of the Series compensation ,variable impedance type series compensator GCSC

and TSSC, operating control schemes for GCSC and TSSC , SSR (sub synchronous resonance) , switching converter type series compensators SSSC , internal schemes for SSSC, external control schemes for series reactive compensators , characteristics of series compensator .

UNIT V **08 Hours**

5. **Static voltage and phase angle regulation TCVR and TCPAR**: Objective of voltage and phase angle regulators, thyristor controlled voltage and phase angle Regulator, switching converter based voltage and phase angle regulators.

UNIT VI **07 Hours**

6. **Combined compensator: UPFC and IPFC.** UPFC - basic principle and reactive Power control scheme for UPFC, comparison of UPFC to Series compensator and phase angle regulations. IPFC-basic operating principle, control structure and its applications.

TEXTS AND REFERENCES:

- Understanding FACTS - Concept and Technology of flexible AC Transmission systems. N.G. Hingorani & L. Gywgyi IEE Press.
- Static Reactive power compensation : T.J.E. Miller, John Wiley and sons New
- FACTS : Yong Hua soug, Allan Johns
- Flexible AC Transmission System: Modeling and Control -2nd Edition Springer by Xiao-ping Zhang.
- Facts Controller In Power Transmission And Distribution by K.R.Padiyar Edited by New Age International Publishers
- Flexible AC Transmission System By Sushmita Panda

6. ELECTIVE-I

SIGNAL PROCESSING FOR ELECTRICAL ENGINEERING

Teaching Scheme: Examination Scheme:
Lectures: 4 hrs / week Theory: 100 Marks

UNIT-1 Digital Signals and Systems (08 Hrs)
DSP system concept, properties of DSP system, types of systems, Interconnection of DSP systems, Recursive and Non recursive system, Some elementary signals and their responses.

UNIT-2 The Discrete Fourier Transform and Fast Fourier Transform (08Hrs)
DFT, Relation between DFT and Z-transform, Properties of DFT, Linear Convolution Circular Convolution-DFT, FFT Algorithms, Use of DFT as Linear Filtering, DIT (Decimation in time), DIF (Decimation in frequency), Implementation aspects, Fast convolution signal segmentation (overlap save algorithm overlap-add algorithm), Correlation-Circular correlation, DFT property of circular correlation.

UNIT-3 Realization and Application of Digital Linear System (06 Hrs)
Filter categories, IIR direct form structures, cascade, parallel realization, FIR filter realization, Different Forms of Realization (Direct and its Transposed, Series, Parallel, lattice).
Application of DSP: measurement, Radar system, image processing..

UNIT-4 FIR Filter Design (08 Hrs)
Characteristics of FIR filter, Properties of FIR filter, Digital network for FIR Filter, Windowing method, Filter design using Kaiser Window, Hanning, Hamming, Barlett, Blackman, Frequency sampling method, Linear FIR filters and types.

UNIT-5 IIR Filter Design (08Hrs)
Impulse Invariant Technique, Bilinear transformation, Frequency band transformation, Analog filter approximation, (Butterworth, Chebyshev, Elliptic), (sin x)/x Digital Correction, Filter. Quantization and Rounding Problems, effects of Finite Word length on stability and frequency response.

UNIT-6 Multirate DSP System & TMS 320 DSP Controller: (06Hrs)
Concept of Sampling Theorem (Nyquist Criterion), Requirement of changing sampling rate, Various methods of sampling rate conversion (Decimation, Interpolation), Benefits of up sampling and down sampling, Introduction, architecture and applications of TMS 320 DSP Controller.

Rereference Books:

1. S. K. Mitra, “Digital Signal Processing”, Tata McGraw Hill Publication.
2. Ramesh Babu, “Introduction to Digital Signal Processing” SCITCH Publication.
3. T. Terrel and Lik-Kwan Shark, “Digital Signal Processing: A Student Guide”.

4. G. Proakis, “Digital Signal Processing Principles, Algorithms and Applications” 4th Edition, PEARSO Publication.
5. A.V.Oppenheim and R. W. Schafer, “Discrete Time Signal Processing” PHI Publication.
6. Johnny R. Johnson, “Introduction to Digital Signal Processing” PHI Publication.

6. ELECTIVE-I

INDUSTRIAL AUTOMATION AND SCADA

Teaching Scheme:
Lectures: 04 hrs/week

Examination Scheme:
Theory: 100 marks

Unit 1: Introduction to Automation

Definition of Automation, Goals of Automation, Mechanics and Automation, Low cost Automation, Types of Automation, Relay based automation, Electronic mode of automation, PLC based automation,Current scenario of automation in Industries, Issues of automation in Factory operations. (04 Hr)

Unit 2: Sensors and Transducers

Sensor and Transducer, Performance terminologies, Static and dynamic characteristics, Basic Relay operation: NO & NC,Selection of sensors, Displacement, position and proximity sensors, Velocity and motion sensors, Force sensor, field pressure sensor, Liquid flow sensors, Liquid level sensors, Temperature sensors, Lightsensors. (12 Hr)

Unit 3: Programmable Logic Controllers

Programmable logic controller, Various brands of PLC, Basic PLC structure, Types of PLC, Inputs and Outputs, Remote I/O, Sourcing and Sinking, Ladder Programming, Verification of Logic functions, Latching and internal relays, Timers, Counters, Comparators, Jump and call, Subroutine, Examples of Ladder programs with Industrial applications. (10 Hr)

Unit 4: Introduction to SCADA systems

Evolution of SCADA system, SCADA definition, System architecture of SCADA, Overview of SCADA System Security Issues, SCADA and IT Convergence, Conventional IT Security and Relevant SCADA Issues, Desirable properties of SCADA system,Interfacing of SCADA with PLC and External hardware. (06 Hr)

Unit 5: SCADA systems in industries

Implementation of SCADA Systems, Petroleum Refining, Nuclear Power Generation, Conventional Electric Power Generation, Petroleum Wellhead Pump Control, Water Purification System, Crane Control, SCADA systems in chemical plants.(08 Hr)

Unit 6: Power system planning and automation

Introduction, Factors affecting system planning, Present planning techniques in power system, Planning models, Future trends in power system planning, systems approach, Substation and distribution system automation. (08 Hr)

Text books:

1. Krutz,Ronald. L, **"Securing SCADA Systems",** 2nd Edition, Wiley, 2005.
2. William Bolton**, "Programmable Logic Controllers",** 6th Edition, Newnes, 2015.
3. William Bolton**, "Mechatronics",**4th Edition, Pearson, 2010
4. Turan Gonen, **"Electric power distribution system engineering",** CRC Press, 2nd Edition.

Reference books:

1. Dr. M.K.Khedkar, Dr. G.M. Dhole, **"A textbook on Electric power distribution automation",** University science press.
2. A.K Gupta, S.K Arora, **"Industrial Automation and Robotics",** 2 nd Edition, University Science press.

6. ELECTIVE – I

RESTRUCTURED POWER SYSTEMS

Teaching Scheme		**Examination Scheme**	
Lectures:	4 Hr/Week	Theory:	100
Tutorial:	--	Term work:	--
Practical:	--	POE:	--
Total:	4 Hr/Week	Total:	100

SECTION I

Unit 1 **(10 hrs)**

Overview of Restructured Power System

Regulation and Deregulation, Vertically Integrated and Deregulated power industry, Market models, Market Clearing Price(MCP), Independent System Operator(ISO), Role of ISO, Ancillary Service Management, Deregulation in Power Industry (Technical and Economic Issues)

Unit 2 **(10 hrs)**

Economic Considerations in Restructured Power System

Introduction, Consumer and Supplier behavior, Demand elasticity, Supply elasticity, Short-run and Long-run costs, various costs of production. Electricity pricing : Electricity pricing in Generation, Transmission and Distribution, Introduction to Marginal cost, opportunity Costs, Dynamic pricing mechanism (ABT), Price elasticity of demand, Tariff setting principles, Distribution tariff for H. T. and L. T. consumers

Unit 3 **(6 hrs)**

Global Models of Restructured Power System

Market Evolution and Deregulation in UK, USA, South America, Nordic pool, China, PJM ISO, and New York Market.

SECTION II

Unit 4 **(8 hrs)**

Indian Power Market Evolution

Electricity Act 2003 and various national policies and guidelines, Ministry of Power, Role of CEA, CERC, state ERC, Load Dispatch Centers etc., Implications of ABT tariff on Indian power sector, Introduction to Indian Power Exchange

Unit 5 **(8 hrs)**

Transmission Pricing and Congestion Management

Transmission price components, various transmission pricing mechanisms, Tracing of power, Network usage and Loss Allocation. Introduction to Congestion in Transmission network, methods of Congestion Management

Unit 6 **(6 hrs)**

OASIS

Introduction of OASIS, Structure of OASIS, Pooling of information, Transfer capability on OASIS and various concepts like ATC, TTC, TRM, and CBM

Text Books

1. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker.
2. "Know Your Power" , A citizens Primer on the Electricity Sector, PRAYAS Energy Group, Pune

Reference Book

1. Daniel Kirschen, Goran Strbac, "Fundamentals of Power System Economics", John Wiely & Sons Ltd. 2004
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
3. Steven Stoft,"Power system economics: designing markets for electricity", John Wiley and Sons, 2002.
4. Sally Hunt, "Making competition work in electricity", John Wiely & Sons, Inc., 2002
5. Loi Lei Lai, "Power System Restructuring and Deregulation" John Wiley and Sons

6. Seminar

The topic of the seminar shall be selected by reviewing minimum 5 references from reputed journals . The seminar should be presented along with bound report before end of semester. The faculty incharge should see that the topics for seminar shall cover recent advancement in electrical engineering and its applications.

The seminar should be delivered for minimum of 20 minutes followed by question and answer session.

It is mandatory for all students to attend the seminar**.**

7. PROJECT I

The project work should be based on hardware assembly. In first phase, the batch of maximum 5 students should finalize the theme of the project in consultation with guide. The circuit should be finalized and the results of simulation shall be presented in the report of project phase I.

SEMESTER II

LAW FOR ENGINEERS

Teaching Scheme:
Lectures: 2 Hours /week

Examination Scheme:
Paper: 50 Marks

The objective of the course is to familiarize students (Prospective engineers) with elementary knowledge of laws that would be of utility in their profession. The syllabus covers Constitution of India and new areas of law like IPR, ADR, Human Rights, Right to Information, Corporate law,

Module 1: Constitutional Law and Law of Contract covering the Preamble; Fundamental Rights, Judicial Structure, Types of Petition, Structure of Legislation

General Principles of Contract under Indian Contract Act, 1872 covering General principles of contract – Sec. 1 to 75 of Indian Contract Act and including Government. as contracting party, Kinds of government contracts and dispute settlement, Standard form contracts; nature, advantages, unilateral character, principles of protection against possibility of exploitation, judicial approach to such contracts, exemption clauses, clash between two standard form contracts; *(6 Lectures)*

Module 2: Human Rights and Public International Law covering Human Rights in International Law-Theoretical foundation, human rights and international law; Historical development of human rights; Human Rights in Indian tradition and Western tradition; Covenant on Civil & Political Rights 1966 including Optional Protocol – I (Individual Complaint Mechanism) & Optional Protocol – II (Abolition of Death Penalty); Covenant on Economic, Social and Cultural Rights 1966 including Optional Protocol – I (2002); UN Mechanism and specialized agencies,(UNICEF, UNESCO, WHO, ILO, FAO, etc.); International NGOs – Amnesty International,Human Rights Watch, Greenpeace Foundation; Enforcement of Human Rights in India including Supreme Court, High Courts, Statutory Commissions – NHRC, NCW, NCM, NC-SCST etc. Public International Law, covering Introduction, Customs, Treaties, State territories including Recognition of States and governments, Law & Practice of Treaties and Law of Sea; *(5 Lectures)*

Module 3: Law relating to Intellectual property covering Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Other new forms such as plant varieties and geographical indications; International instruments on IP – Berne convention, Rome convention, TRIPS, Paris convention and international organizations relating IPRs, WIPO, WTO etc; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – literary, dramatics and musical works, sound records and cinematographic films, computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Trademarks under Trademark Act, 1999 including Rationale of protection of trademarks as Commercial aspect and Consumer rights, Trademarks, registration, procedures, Distinction between trademark and property mark, Doctrine of deceptive similarity, Passing off an infringement and remedies; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of

obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies; *(8 Lectures)*

Module 4: Right to Information Act, 2005 covering, Evolution and concept; Practice and procedures; Official Secret Act, 1923; Indian Evidence Act, 1872; Information Technology – legislation and procedures, Cyber crimes – issues and investigations; *(3 Lectures)*

Module 5: Labour Laws, covering Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen‟s Compensation Act, 1923; *(3Lectures)*

Module 6: Corporate Law, covering Meaning of corporation; Law relating to companies, public and private (Companies Act, 1956) general provisions; Law and multinational companies – International norms for control, FEMA 1999, collaboration agreements for technology transfer; Corporate liability, civil and criminal; *(4 Lectures)*

Text/Reference Books:

1. B. K. Goel,Business Law for ManagersBiztantra, Indian Test edition
2. D.D. Basu (1996), *Shorter Constitution of India*, Prentice Hall of India
3. M.P. Jain (2005), *Indian Constitutional Law*, Wadhwa & Co.
4. Agarwal H.O.(2008), *International Law and Human Rights,* Central Law Publications
5. Meena Rao (2006), *Fundamental concepts in Law of Contract, 3rd Edn.* Professional Offset
6. Cornish W. R. (2008), *Intellectual Property Rights, Patents, Trademarks, Copyrights & Allied Rights*, Sweet& Maxwell
7. Wadhera (2004), *Intellectual Property Rights,* Universal Law Publishing Co.
8. Bare text (2005), *Right to Information Act*
9. O.P. Malhotra, *Law of Industrial Disputes*, N.M. Tripathi Publishers
10. K.M. Desai(1946), *The Industrial Employment (Standing Orders) Act*
11. Rustamji R.F.,*Introduction to the Law of Industrial Disputes*, Asia Publishing House
12. Avtarsingh (2007), *Company Law*, Eastern Book Co.
13. R.R. Pennington, *Company Law*, Butterworth Publications

2. H.V.D.C. SYSTEMS [New 2016]

Teaching Scheme:
Lectures: 4 Hours /week
Practical: 2 Hours/week

Examination Scheme:
Paper: 100 Marks
POE- 50 MARKS

1.General Background: Trends in transmission Voltages, Hierarchical Levels in transmission and distribution, Standard rated voltage of EHV-AC and HVDC, General aspects HVDC Transmission: Constitution of EHVAC and DC links, Kinds of DC links, HVDC projects in India and abroad, limitations and advantages of HVDC transmission over EHVAC, Layout of HVDC station. Deep Hole Ground Electrode, Electrolytic Corrosion, factors for General Design of Electrodes. **8 Lec**

2.**Grid Control and Characteristics:** Grid control of thyristor, valve-Analysis with grid control with no overlap, overlap less than 60 degrees and overlap greater than 60 degrees. Basic means of control, Power reversal, manual control and its limitations-constant current versus constant voltage Control, desired features of control, actual control characteristics-constant minimum ignition angle, current and extinction angle controls –power control and current limits. Voltage Dependant Current Limiter (VDCOL), Comparison of Converters - CSC & VSC systems **10 Lec**

3.**Protection:** Disoperation of converters-short circuit on a rectifier – commutation failure, causes and remedies – Protection of HVDC system, d.c. rectors, damper circuits, Over current protection and over-voltage protection, clearing fault and reenergizing the line. **6 Lec**

4.**Harmonics and Filters:** Characteristic and uncharacteristic harmonics-causes, consequences and suppression-Troubles caused by harmonics, Harmonic filters- Types, Location, series or shunt, sharpness of tuning, Quality Factor Q for L, C & RLC filter**.** **6 Lec**

5.**Reactive Power Compensation:** Reactive Power Requirement of HVDC Converter- reactive Power balance in HVDC substations-Effect of angle of advance and extinction angle on reactive power requirement of converters. **4 Lec**

6.**Multi-terminal DC Systems & Hvdc Light:** Introduction, Configurations and Types of MTDC Systems, Control and Protection of MTDC Systems Configurations and Types of MTDC Systems, Reversal of Power in MTDC System, Comparison between MTDC and AC Interconnections HVDC Light :- Introduction to VSC transmission & Structure , Introduction to HVDC light technology. **10 Lec**

TERM WORK:

Minimum 8 experiments to be performed based on simulation:
A] MATLAB/SIMULINK/PSCAD/EMBTC or PSPICE may be used for simulation.

1. Study state & transient performance of 12 pulse HVDC transmission system.
2. Study & Simulation of Thyrister Based HVDC Model.
3. Simulation to study Vd-Id characteristics with constant minimum ignition angle control for controlled rectifier.
4. Study Simulation model of HVDC system (with bridge Rectifier and SPWM Inverter).
5. Simulation to Study Vd-Id characteristics with constant extinction angle control of inverter.
6. Simulation to study three phase SPWM Inverter.
7. Study of effect of angle of advance and extinction angle on reactive power on the converter and inverter side.
8 . Simulation to Study of harmonics generated on converter and inverter side due to angle of advance and extinction.
9. Simulation to study effect of Tuned Filters on the converter harmonics.
10. Simulation to study Low AC Voltage Detection & Voltage Dependant Current Order Limiter (VDCOL)
11. Simulation to Study working of Commutation Failure Prevention Control (CFPREV)
12. Simulation to study AC line to ground fault on inverter Side
13. Study and simulation of 6 pulse HVDC system & observe Vd-Id characteristics.
14. Simulation to study on three phase controlled rectifier & observe Vd-Id characteristics
15. Harmonic analysis on sinusoidal waveform and working of sinusoidal PWM inverter.
16. Simulation to study 12 pulse converter with 2 six pulse converter & observe Vd-Id characteristics
17. Study & Simulation of VSC based HVDC transmission link & observe Vd-Id characteristics
18. Study & Simulation of Simulation of single phase SPWM Inverter & observe Vd-Id characteristics

B] Compulsory One field visit to HVDC Station.

Text Books:

1.Edward Wilson Kimbark "Direct Current Transmission" Wiley publication Inter science
2. K R Padiyar "HVDC power transmission systems" second edition, New Age International (p)Ltd
3. S. Kamkshaiah and V Kamraju "HVDC transmission" Tata Mc Graw Hill Education Pvt. Ltd, New Delhi

Reference Books:

1.S. Rao" EHVAC and HVDC Transmission Engineering and Practice" –Khanna publication,

1990
2. J.Arrillaga “HVDC Transmission” – Wiley publication Inter science
3. C.L. Wadhwa “Electrical Power System (2nd Edition)”
4. Vijay K. Sood, “*HVDC and FACTS Controllers*: Applications of Static Converters in Power Systems”- Kluwer Academic Publishers 2004.
5. J. Arrillaga, Y. H. Liu, N. R. Watson ,”Flexible Power Transmission: The HVDC Options” Wiley publication Inter science

2. EHVAC

Teaching Scheme: Examination Scheme:
Lectures: 4 hrs / week Theory: 100 Marks

UNIT-1 Introduction to EHVAC & Calculation of line and ground parameters (10 Hrs)
Engineering aspect and growth of EHVAC Transmission line trends and preliminaries, power transferability, transient stability, transient stability limit, and surge impedance loading. Resistance power loss, temperature rise properties of bundled conductors, Inductance and Capacitance, calculation of sequence inductions and capacitance line parameters for modes of propagations, resistance and inductance of the ground return.

UNIT-2 Voltage gradients of conductor (8 Hrs)
Charge potential relations for multi-conductor lines , surface voltage gradients on the conductor line , surface voltage gradients on conductors, distribution of voltage gradients on sub conductors of bundle. I*I * R and corona loss corona loss formula charge voltage diagram with corona ,attenuation of traveling waves due to corona loss Audible noise, corona pulses, Their generation and properties, limit for radio interface fields.

UNIT-3 Theory of the Traveling waves and standing (6 Hrs)
The waves at the power frequency, differenential equations and solutions for general case, standing waves and natural frequencies open ended line double exponential response, response to sinusoidal Excitation, line energization with trapped charge voltage, Refection and refraction of traveling waves.

UNIT-4 Lighting and lighting protection & Insulation Co-ordinations (10 Hrs)
Lighting strokes to lines, their mechanism, General principal of the lighting protections problems, low footing resistance, lighting arrestor and protection characteristics different arrestors and their characteristics. Insulation level, Voltage withstands levels of protected equipments and insulation condition based on the lighting.

UNIT-5 Over voltage in EHV system convered by switching operation (8 Hrs)
Over voltage in EHV system covered by switching operations over –voltage their types, recovery voltage and circuits breaks, Ferro resonance over voltage and calculations of switching surges single phase equivalents.

UNIT-6 Power frequency voltage control and over voltages (6 Hrs)
Generalized constants, charging current, power circle diagram, and its use, Voltage control shunt and series components, Sub synchronous resonance in series capacitor compensated lines and static reactive compensating systems.

Texts and references:

1. Rakosh Das Begamudre ,"Extra high voltage AC transmission engineering", New Age Publication
2. EHV –AC and HVDC Transmission Engineering &Practice : S.V. Rao
3. EHV -AC and HVDC transmission system engineering analysis and design: John Wiley & sons.

3. ELECTRICAL GENERATION & UTILIZATION

Teaching Scheme	Examination Scheme
Lectures: 4 Hrs / week	Theory: 100 Marks
Tutorial: 2 Hrs / week	TW: 50 Marks

Unit I: Electrical Energy Generation using Conventional Energy Sources: 8hr

Electric energy demand, Electric energy growth in India, Power crisis in India. Types of Generation: Diesel & Gas Power Plant: Advantages, Disadvantages, applications of Diesel plant. Gas Turbine plant: Principle of operation, Open cycle, closed cycle plant & Applications of gas plant. Thermal power plant: Main & auxiliary equipments in Thermal plant. Hydro electric Plant: Advantages, disadvantages, & Classifications of hydro plant. Nuclear Power Plant: Main parts of nuclear plant, advantages & disadvantages of nuclear plant. Co Generation: Technologies, Industries suitable for Cogeneration.

Unit II: Solar Energy: 8hr

A) Introduction, Beam & Diffuse solar radiation, Measurement of solar radiation, Derived solar angles, sunrise sunset & day length, sunrise hour angle, solar collectors, storage of solar energy, solar water heaters, distillation, solar still, solar cooker, estimation of average solar radiation.

B) Solar Photovoltaic: Introduction, Solar cell characteristics & losses. Emerging solar technologies, Solar PV modules, Design of PV module, Sizing of Battery, inverter & charge controller.

C) PV module power output, IV curve for PV module, batteries for PV cell, Battery charge controllers, Types of PV systems: Grid tie PV system, Stand alone PV system, direct PV system.

Unit III: Wind Energy: 8hr

A) Introduction, Principle of wind energy conversion, power duration & velocity duration characteristics of wind, advantages & disadvantages of WECS, Classification of wind mills, basic components of wind mill, aerodynamic forces acting on wind mill blades, Design considerations of horizontal axis & vertical axis wind mill, Wind Data & site selection considerations, Social economic & environmental considerations.

Section –II

Unit-IV: Electric Heating and Welding 8hr

Classification of electric heating, heating methods, Resistance heating, design of heating element, Arc furnaces, induction heating, Induction furnaces, Dielectric heating, Electric arc

welding, welding transformer, Power supply and control of electric welding, Laser beam welding.

Unit-V: Electric traction **8hr**

DC, AC and composite traction systems, main line and suburban systems, Comparison with Diesel-Electric traction, traction equipments, Trolley wire, catenaries, Feeding and distribution systems, negative booster, overhead lines, current collectors, traction substations .

Unit-VI **8hr**

A)Train movement and Energy consumption: Trapezoidal and quadrilateral speed-time curves, Maximum, average and scheduled speeds, Mechanics of train movement, tractive effort calculation, Power and energy output from driving axles, Specific Energy Output.

B) Braking & control of traction motors: Vacuum brake and Air brake systems, regenerative braking, calculation of energy returned during regenerative braking. D.C. series, A.C. series and 3 Phase Induction motors for traction, Brief introduction to rheostatic speed control methods, drum controller, Multiple Unit Control, Static control of traction morors. Use of microprocessors for control of traction motors.

Texts and references:

1. Generation of Electrical energy by Dr. B.R. Gupta. S. Chand Publications.
2. Non Conventional & Renewable energy sources by S.S. Thipse Narosa publishing house.
3. Utilization of Electric Power and Electric Traction: J.B. Gupta, 8th Edition
4. Art and science of Utilization of Electric Energy: H. Partab
5. A course in Electrical Power: Soni, Gupta and Bhatnagar
6. Utilization of Electric Energy: Openshaw Taylor

5. Elective- II

Embedded System

Teaching Scheme: Examination Scheme:
Lectures: 04 hrs/week Paper: 100 marks
Practical: 02 hrs/week Term work: 50 marks.

UNIT -1

Introduction to Embedded Systems: What is an Embedded System, Embedded Systems vs. General Computing Systems, History of Embedded Systems, Classification of Embedded Systems, Major Application Areas of Embedded Systems, Purpose of Embedded Systems **The Typical Embedded System** : Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components, PCB and Passive Components.

UNIT -2

Characteristics and Quality Attributes of Embedded Systems : Characteristics of an Embedded System, Quality Attributes of Embedded Systems.

Embedded Systems-Application-and Domain-Specific : Washing Machine-Application-Specific Embedded System, Automotive-Domain-Specific Examples of Embedded System,

Designing Embedded Systems with 8 bit Microcontrollers – 8051: Factors to be Considered in Selecting a Controller, Why 8051 Microcontroller.

UNIT - 3

Hardware Software Co-Design and Program Modelling: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modelling Language (UML), Hardware Software Trade-offs

UNIT - 4

Embedded Hardware Design and Development : VLSI and Integrated Circuit Design, Electronic Design Automation (EDA) Tools, How to use the OrCAD EDA Tool?, Schematic Design using Orcad Capture CIS, The PCB Layout Design, Printed Circuit Board (PCB) Fabrication.

Embedded Firmware Design and Development : Embedded Firmware Design Approaches, Embedded Firmware Development Languages, Programming in Embedded C.

UNIT - 5

The Embedded Product Development Life Cycle (EDLC) : What is EDLC? , Why EDLC, Objectives of EDLC, Different Phases of EDLC, EDLC Approaches (Modeling the EDLC),

Trends in the Embedded Industry : Processor Trends in Embedded System, Embedded OS Trends, Development Language Trends, Open Standards, Frameworks and Alliances, Bottlenecks.

UNIT - 6

ARM Processors : Introduction to ARM Family of Processors, programming.

Design Case Studies : Digital Clock, Battery-Operated Smartcard Reader, Automated Meter Reading System(AMR), Digital Camera.

Term Work: List of Experiments:

Toatl of 08 experiments to be carried out. 04 based on ARM processor / any processor other than 8051 preferably with interfacing, 04 on IDE simulation.

Texts and references:

1. Introduction to embedded Systems: K.V.Shibu, Mc Graw Hill Education.
2. ARM system developers guide designing & optimizing system software : Andrew N, Dominic Sloss and Chris Wright.

5. Elective- II

HIGH VOLTAGE ENGINEERING [New 2016]

Teaching Scheme: Examination Scheme: Paper: 100 Marks
Lectures: 4 Hours /week
Practical: 2 Hours/week T.W.: 50 Marks

COURSE OUTCOME:-

After learning the course the students should be able to

1. Understand the basic generation and measurement of High voltage and High current for testing purposes
2. Comprehend Breakdown phenomenon in air, solid and liquid insulation
3. Test & analyse high voltage electrical Equipment with various testing devices.
4. Design different types of HV generators

1.Electrostatic fields and field stress control : 4 lec

Electrical field distribution and breakdown strength of insulating materials - fields in homogeneous, isotropic materials - fields in multi-dielectric, isotropic materials - numerical method: Finite difference method , charge simulation method (CSM)

2.Electrical breakdown in gases, liquid and solid dielectrics 10 lec

Gases as insulating media - ionization and decay processes, Townsend first ionization coefficient, photoionization, ionization by interaction of metastable with atoms, deionization by recombination, photoelectric emission, thermionic emission, Townsend second ionization coefficient, the Townsend mechanism, examples - the streamer or 'kanal' mechanism of spark, Paschen's law,

Liquid as insulators, breakdown in liquids - electronic breakdown, suspended solid particle mechanism, cavity breakdown, transformer oil filtration, transformer oil test,

Breakdown in solids, intrinsic breakdown, streamer breakdown, electromechanical breakdown, breakdown due to treeing & tracking, thermal breakdown, solid dielectrics used in practice.

3. Generation of high voltages : 7 lec

Generation of high direct voltages, half and full wave rectifier circuits, voltage multiplier circuits, Cockroft-Walton Voltage Multiplier Circuit working, Van de Graff generators, Tribo-electric Effect , electrostatic generators, generation of alternating voltages, cascaded transformers, resonant transformers- series, parallel, impulse voltages, Standard lightning and switching surge, impulse voltage generator circuits, Analysis of circuit "a", Marx circuit, operation, impulse current generator.

4. Measurement of high voltages : **9 lec**

High direct voltage measurement, peak voltage measurements by spark gaps, sphere gaps, reference measuring systems, uniform field gaps, rod gaps, factors affecting sphere gap measurements, examples , electrostatic voltmeters , generating voltmeters and field sensors, Potential Dividers for Impulse Voltage Measurements- resistance & Capacitance voltage divider, Measurement Of High D.C., A.C. And Impulse Currents- hall generators, rogowaski coil, Faraday Generator , the measurement of peak voltages, the Chubb–Fortescue method, Surge Recorder (Klydonograph) with Litchenberg Pattern.

5. Over voltages, insulation coordination & Non-destructive insulation tests:- 8 lec

Natural causes for over voltages, Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems

Measurement of d.c. resistivity, dielectric loss and Loss factor, The Partial Discharge-internal & external, Equivalent Circuit.

6.High voltage testing: 6 lec

Testing of insulators and bushings, testing of isolators and circuit breakers Testing of cables, testing of transformers - testing of surge diverters

Planning and layout of high voltage laboratory:- Classification of High Voltage Laboratories, Layout of High Voltage Laboratories, working of Faradays Cage.

TERM WORK:

A] List of Experiments:

1. Partial Discharge Measurements of Transformer windings and Cables
2. Impulse Tests on Transformers
3. Capacitance Measurement of Cables
4. Condition Monitoring Of Transformers
5. Transformer oil Testing
6. Measurement of Dielectric properties with Schering Bridge
7. Insulation Testing of Cables, wires
8. A report on visit to high voltage laboratory
9. Application of High Voltage in Domestic level- Demonstation of working of Mosquito Rackets, Electric gas Lighters, High Voltage Stun gun, microwave ovens., Electronic Pulse igniter, CRT devices.

Texts and references :

1. High Voltage Engineering: M.S.Naidu and V. Kamaraju, TMH Publications, 3rd Edition
2. High Voltage Engineering: Fundamentals: E.Kuffel, W.S.Zaengl, J.Kuffel , Elsevier
3. High Voltage Engineering: C.L.Wadhwa, New Age Internationals (P) Limited, 1997.
4. High Voltage Insulation Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995.

5. Elective II
Advanced Relaying

Teaching Scheme:
Lectures:4 Hours /week
Practical: 2 Hours/week

Examination Scheme:
Paper: 100 Marks
T.W.: 50 Marks

1.Introduction to Digital Relay: Introduction, Basic Components of Digital Relays with block diagram advantages of microprocessor technology, microprocessor application to protection, measures of noise and surge immunity, desirable features in a protection scheme, integrated hierarchical computer control and protection, subsystems of a digital relay, operating algorithms, substation digital protection system, adaptive relaying, simulators for testing.
(9Hr)

2.Coordination of Inverse Definite Minimum Time (IDMT)/Directional Over Current (DOC) Relays in an Interconnected Power System Network: Protection of an interconnected system, Link net structure, Flowchart of Primary/ Backup relay pairs, Flowchart of Time Multiplier Setting. Examples based on existing power system network (5Hr)

3.Current Voltage Transformers: Introduction, current transformers, equivalent circuits, transient performance, modeling for transient simulation, use of mimic impedance, voltage transformers, VT model, modeling for transient simulation, wound voltage transformers, relay performance, dynamic compensation for CTs and PTs, compensating algorithms for CTs and dynamic compensation of CTs, analysis of simulation results. Study of electromagnetic CT & PT, Steady state & Transient state analysis of CVT, Study of residual voltage transformer, natural CT, Mixing Transformer, summation transformer, Optical CT
(9Hr)

4. Comparator: Characteristic & study of different types of two input phase & amplitude Comparator, Study of multi input comparator
(3Hr)

5.Auto-reclosing and Synchronizing
Introduction, history of auto-reclosing, advantageous of auto-reclosing, classification of auto-reclosing, auto-reclosing based on number of phases, auto-reclosing based on number of attempts, auto-reclosing based on speed, factors to be considered during reclosing such as choice of zone in case of distance relay, dead time, reclaim time, instantaneous, trip lockout, intermediate lockout, breaker supervision function
(6Hr)

6. Protection of Power System Components: Introduction, bus bar protection, digital protection schemes for bus bars.
(4Hr)

a)Transformer Protection: Introduction, digital techniques for protection of transformers, harmonic restraint percentage differential protection, voltage restraint technique, flux restraint approach. (4Hr)

b)Digital Relays for Synchronous Generators Protection: Introduction, multifunction protection scheme, differential protection of stator windings, 100% stator ground fault protection, negative sequence protection, under impedance protection, out of set generator protection, over-fluxing detection algorithm.

(4Hr)

c)Protection Features in Numerical Distance Relays: Relaying algorithms, distance relay characteristics, multiprocessor based poly-phase numerical distance relay, feeder protection, introduction, special over current relay characteristics, typical numerical over-current relay, motor protection.

(4Hr)

REFERENCE BOOKS

1. K. Parthasarathy, "Digital Protection of Power Systems", ISTE WPLP Learning Material Series, Indian Society for Technical Education, Bangalore, 2006.
2. T.S.Madhava Rao, "Power System Protection – Static Relays", 2nd Edition, TMH Publication, 2009.
3. Arun G. Phadke, James S.Thorp, "Computer Relaying f or Power Systems", John Wiley and Sons Inc, 2nd Edi tion, 2009.
4. A.T.Johns and S.K.Salman, "Digital Protection for Power Systems" Peter Peregrinus Ltd, Institution of Electrical Engineers, 1997.
5. T.S.M. Rao, Digital/Numerical Relays, TMH,2005.
6. Bhavesh Bhalja, R. P. Maheshwari and N. G. Chothani, "Protection and Switchgear," Oxford University Press, New Delhi, India, 2011.
7. Fundamentals of power system protection by Y.G.Paithankar, S.R.Bhide., Prentice hall, India, second edition, 2010."

5. Elective II
ELECTRICAL MAINTENANCE AND ENERGY AUDIT

Unit 1: Maintenance: Types of maintenance, maintenance schedules, procedures, Maintenance of Motors: Over hauling of motors, preventive maintenance, trouble shopping of electric motors. Maintenance of Transmission and Distribution System, danger notice, caution notice permit to work, arranging of shutdowns personally and temporary earths cancellation of permit and restoration of supply, Patrolling and visual inspection of lines – points to be noted during patrolling from ground: special inspections and night inspections, Location of faults using Meggar, effect of open or loose neutral connections provision of proper fuses on service lines and their effect on system, causes and dim and flickering lights. (**10)**

Unit 2: Maintenance of Distribution Transformers: Transformer maintenance and points to be attended to be attended to in respect of various items of equipment, Checking of insulation resistance transformer oil level and BDV test of oil, measurement of earth resistance. (**08)**

Unit 3: Maintenance of Grid Substations: Checking and maintenance of bus bars, isolating switches, HT/LT circuit breakers, LT switches, Power Transformers. (**06)**

Unit 4: General Aspects of Energy Management and Energy Audit (6)

Definition, Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.

Unit 5: Energy Audit Methodology & Recent Trends (10)

Current Practices, Integration of two or more systems, Switching of Energy Sources, Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS ,Case-studies / Report studies of Energy Audits. Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities.

Unit 6: Energy Efficiency in Electrical Utilities (8)

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

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

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

Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation avenues.

Practical Exercise:-

1. Identification of tools and equipment used for installation and maintenance of electrical equipment

2. Study of codes and practices pertaining to safety in installation and maintenance of electrical equipment.

3. Study of electrical equipment by visiting a grid power station/sub station and to prepare a report of maintenance system adopted there

4. Study of the testing of electrical equipment by visiting a grid power station/sub station and to prepare a report

5. Study of motors and their repair and overhauling by visiting a repair workshop or manufacturing unit

6. Study of maintenance of electrical distribution system by visiting a sub station and to prepare a report.

7. Study of Power factor improvement of a single-phase load using capacitor bank

B) One field visit to substation for study of maintenance work.

Reference Books:

1) Testing, Commissioning Operation and Maintenance of Electrical Equipment : S Rao, Khanna Technical Publication ,New Delhi.
2) Preventive Maintenance of Electrical Apparatus : SK Sharotri, Katson Publishing House Ludhiana
3) Electric Energy Generation, Utilisation and Conservation Sivaganaraju, S Pearson, New Delhi, 2012
4) Energy Management: W.R.Murphy, G.Mckay (Butterworths).
5) Industrial Energy Conservation: D.A. Reay (Pergammon Press)
6) Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Interscience Publication.

6. Project Phase II

The assembly of components shall be done in project II. The testing shall be completed and necessary changes, if required shall be made. The project should be presented before the external examiner in working condition along with documents showing evidences of participation in state/ National level project competition. A journal/conference paper published/ presented on project work is expected. The project batch shall be eligible to gent more than 80% of marks in term work/ external examination if above conditions are satisfied

SE OLD	EQUIVALENT	SE NEW	
SEM III			
Engineering Mathematics-III	Engg. Maths III	Engg. Maths III	
Analog Electronics	Analog Electronic Engineering	Electrical Engineering Materials and Energy Conversion	
Electrical Circuit Analysis	Electromagnetic and Electrical Circuits	Analog Electronic Engineering	
DC Machines and Transformers	DC Machines and Transformer	Electromagnetic and Electrical Circuits	
Generation & Its Economics		Measurements and Instruments	
SEM IV			
Signals and Systems	Signals and systems	DC Machines and Transformer	
A.C. Machines	A.C. Machines	Power Electronics	
Industrial Management and Economics		Power Systems I	
Electrical Measurement	Measurements and Instruments	Network Analysis and Synthesis	
Digital Systems and Microprocessors		Control System I	

TE OLD	EQUIVALENT	TE NEW	
SEM V			
Electromagnetics		Digital Electronics and Microcontroller	
Power Systems Analysis	Power Systems I	A.C. Machines	
Instrumentation Techniques		Power Systems II	
Feedback Control systems	Control System I	Control System II	
Digital Signal Processing	Signal Processing For Electrical Engg.	Signals and systems	
SEM VI			
Power System Stability and Control	Power Systems II	Advanced Electrical Measurements	
Control Systems Design	Control System II	Communication Engineering	
Power Electronics	Power Electronics	Electrical Machine Design	
Microcontroller and its applications	Digital Electronics and Microcontroller	Power Systems III	
Communication Engineering	Communication Engineering	Electrical Drives	

BE OLD	EQUIVALENT	BE NEW	
SEMVII			
Industrial Drives and Control	Electrical Drives	Advanced Switchgear and Protection	
High Voltage Engineering	High Voltage Engineering (Elective)	Power Quality and Harmonics	
Advanced Switchgear and Protection	Advanced Switchgear and Protection	Computer Methods in Power Systems	
Renewable Energy Sources		**Elective-I**	
Elective-I		**1. FACTS**	
1. FACTS	**FACTS**	**2. Signal Processing For Electrical Engg.**	
2. Digital Control System		**3.** Industrial Automation and SCADA	
3. Embedded System	**Embedded Systems**(Elective)	**4. Restructured Power Systems**	
4. Electrical Engineering Materials	Electrical Engineering Materials and Energy Conversion		
5. Thermal Engineering			
SEM VIII			
Electrical Utilization and traction	Electrical Generation and Utilization	HVDC Systems	
HVDC Systems	HVDC Systems	EHVAC	

Electrical Installation, testing and maintenance	**Electrical maintenance and electrical energy audit.**	Electrical Generation and Utilization	
Elective -II		Elective II	
1. EHVAC	EHVAC	**1. Embedded Systems**	
2. Computer Aided power Systems	Computer Methods in Power Systems	**2. High Voltage Engineering**	
3. Advanced Digital Signal Processing		**3. Advanced Relaying**	
4. Restructured Power Systems	**Restructured Power Systems**(Elective)	**4. Electrical maintenance and electrical energy audit.**	