UNIVERSITY OF LUCKNOW
FACULTY OF ENGINEERING& TECHNOLOGY

Evaluation Scheme for B. Tech.

Branch: Electrical Engineering

SEMESTER - VII

S. No.	Subject Code	Subject Name	L-T-P	Evaluation					Credit
				Sessional			ESE	Grand Total	
				CT	TA	Total			
Theory									
01.	EE–701	Switchgear and Protection	3–1–0	20	10	30	70	100	4
02.	EE–702	Electric Drives	3–1–0	20	10	30	70	100	4
03.	EE–703	FACTS Devices	3–1–0	20	10	30	70	100	4
04.	EE–704X	Any one from the list (DE-2)	3–1–0	20	10	30	70	100	4
05.	AS–701/ AS–702	Engineering Economics/ Industrial Management	3–0–0	20	10	30	70	100	3
Practical									
06.	EE–751	Switchgear and Protection Lab	0–0–2	–	20	20	30	50	1
07.	EE–752	Electric Drives Lab	0–0–2	–	20	20	30	50	1
08.	EE–753	Industrial Training	0–0–2	–	–	50	–	50	1
09.	EE–754	Project (Phase–I)	0–0–3	–	–	150	–	150	2
10.	GP–701	General Proficiency				50		50	
Total			**15–4–9**					**800**	**24**

Abbreviations:

CT– Class Test
TA– Teacher's Assessment
ESE– End Semester Examination
DE– Departmental Elective

Departmental Elective (DE)–2:

1. EE–7041 Power System Operation and Control
2. EE–7042 Advanced Power Transmission
3. EE–7043 Applications of Modern Power Electronics in Power System
4. EE–7044 SCADA and Energy Management

UNIVERSITY OF LUCKNOW
FACULTY OF ENGINEERING& TECHNOLOGY

Evaluation Scheme for B. Tech.

Branch: Electrical Engineering

SEMESTER - VIII

S. No.	Subject Code	Subject Name	L-T-P	Evaluation					Credit
				Sessional			ESE	Grand Total	
				CT	TA	Total			
	Theory								
01.	OE–80XX	Any one from the Open Elective list	3–1–0	20	10	30	70	100	4
02.	EE–801X	Any one from the list (DE-3)	3–1–0	20	10	30	70	100	4
03.	EE–802	Instrumentation and Process Control	3–1–0	20	10	30	70	100	4
04.	AS–801/ AS–802	Engineering Economics/ Industrial Management	3–0–0	20	10	30	70	100	3
	Practical								
05.	EE–851	Instrumentation and Process Control Lab	0–0–2	–	20	20	30	50	1
06.	EE–852	Project(Phase–II)	0–0–12	–		100	250	350	8
07.	GP–801	General Proficiency				50		50	
	Total		**12–3–14**					**800**	**24**

Abbreviations:

CT– Class Test
TA– Teacher's Assessment
ESE– End Semester Examination
DE– Departmental Elective
OE– Open Elective

Departmental Elective (DE)–3:

1. EE–8011 SMART Grid
2. EE–8012 Power System Planning and Reliability
3. EE–8013 EHV AC and DC Transmission
4. EE–8014 Power Quality

Open Elective: Refer list of Open Electives in APPENDIX.

EE–701
SWITCHGEAR AND PROTECTION

L	T	P
3	1	0

UNIT-I

Introduction to Protection System:

Introduction to protection system and its elements, functions of protective relaying, protective zones, primary and backup protection, desirable qualities of protective relaying, basic terminology; Introduction to numerical relays.

Relays:

Electromagnetic: attraction and induction type relays; thermal relay, gas actuated relay, design considerations of electromagnetic relay. **09**

UNIT-II

Relay Application and Characteristics:

Amplitude and phase comparators, over current relays, directional relays, distance relays, differential relay

Static Relays:

Comparison with electromagnetic relay, classification and their description, over current relays, directional relay, distance relays, differential relay. **06**

UNIT-III

Transmission Line Protection:

Overcurrent, differential, directional-overcurrent and distance relays, back-up protection, carrier relaying; Busbar protection.

Transformer Protection: internal faults such as short circuit and turn-to-turn fault protection using differential and overcurrent relays, protection for other abnormal conditions. **07**

UNIT-IV

GeneratorProtection: short circuit and turn-to-turn fault, stator to ground fault, field to ground fault, loss of excitation, loss of synchronism protection using different types of relays.

Circuit Breaking:

Properties of arc, arc extinction theories, re-striking voltage transient, current chopping, resistance switching, capacitive current interruption, short line interruption, circuit breaker ratings. **08**

UNIT-V

Circuit Breakers:

Operating modes, selection of circuit breakers, constructional features and operation of Bulk Oil, Minimum Oil, Air Blast, SF6, Vacuum and DC circuit breakers,auto-reclosing - definitions & features, Three-Phase versus Single-Phase auto-reclosing

Testing Of Circuit Breakers:

Classification, testing station and equipments, testing procedure, direct and indirect testing. **10**

Text Books:

1. S. S. Rao, “Switchgear and Protection”, Khanna Publishers.
2. B. Ravindranath and M. Chander, “Power system Protection and Switchgear”,New Age International Publishers.

Reference Books:

1. B. Ram and D. N. Vishwakarma, “Power System Protection and Switchgear”, Tata Mc Graw Hill.
2. Y. G. Paithankar and S. R.Bhide, “Fundamentals of Power System Protection”, Prentice Hall of India.
3. T. S. Madhava Rao,“Power System Protection: Static Relays: with Microprocessor Applications” Tata McGraw Hill.
4. A. R. Van C. Warringtaon, “Protective Relays- Their Theory and Practice, Vol. I & II”, Springer.

EE–702
ELECTRIC DRIVES

L	T	P
3	1	0

UNIT-I

Introduction to Electric Drive: Electric drives and its parts, advantages of electric drives, classification of electric drives, Components of load torque and load torque classification, Characteristics of different types of mechanical loads, Joint torque –speed characteristics of motor and load, Choice of electrical drives, Speed-torque conventions and multi-quadrant operations. **08**

UNIT-II

Dynamics of Electric Drive: Fundamental torque equations of equivalent motor-load combination; Drive parameters for rotational and translational motion: Equivalent torque and moment of inertia, Steady state stability of Electric Drive; Transient stability of electric Drive, Load equalization.

Selection of Motor Power rating: Thermal model of motor for heating and cooling, classes of motor duty, determination of motor power rating for continuous duty, short time duty and intermittent duty. **10**

UNIT-III

Electric Braking: Purpose and types of electric braking, braking of dc, three phase induction and synchronous motors.

Dynamics during Starting and Braking: Effect of starting on power supply motor and load, calculation of time and energy loss in transients operations, dynamics during braking, energy relations during starting and braking of dc shunt and three-phase induction motors, methods of reducing energy loss during starting. **08**

UNIT-IV

Power Electronic Control of DC Drives: Single-phase and three-phase controlled converter fed separately excited dc motor drives(continuous conduction only), dual converter fed separately excited dc motor drive, chopper control of separately excited dc motor and dc series motor, supply harmonics, power factor and ripples in motor current. **06**

UNIT-V

Power Electronic Control of AC Drives: Three-Phase Induction Motor Drive: Static Voltage Control scheme, static frequency control scheme (VSI, CSI, and cyclo-converter based), and static rotor resistance control.

Synchronous Motor Drive: Self-controlled synchronous motor drive

Traction Drives: Characteristics of Traction Drives; Drive Power Requirement; DC and AC Traction. **08**

Text Books:

1. G. K. Dubey, “Fundamentals of Electrical Drives”, Narosa publishing House.
2. S. K. Pillai, “A first course on electric drives”, New Age International Publisher.

Reference Books:

1. V.Subrahmanyam, “Electric Drives: Concepts and applications”, Tata McGraw-Hill.
2. M.A. El-Sharkawi, “Fundamentals of Electric Drives”, Cengage Learning Custom Publishing.
3. N.K. De and P. K. Sen, “Electric Drives”, PHI Learning.

EE–703
FACTS DEVICES

L	T	P
3	1	0

UNIT-I

FACTS concepts and general system considerations: Reactive power control in electrical power transmission lines - Uncompensated transmission line, description and definition of FACTS, basic types of FACTS controllers, benefits from FACTS technology, brief review of voltage sourced converter and current sourced converter. **08**

UNIT-II

Static voltage and phase angle regulator (TCVR and TCPAR): Objectives of voltage and phase angle regulators, approaches to TCVR and TCPAR, switching converter based voltage and phase angle regulators. **06**

UNIT-III

FACTS Controller for shunt compensation: Objectives of shunt compensation, methods of controllable VAR generation, regulation slope, transfer function, V-I and V-Q characteristics, transient stability enhancement, VAR reserve control, conventional power flow models, shunt variable susceptance model, firing angle model, transient stability model, voltage magnitude control using SVC & STACOM, Application example. **09**

UNIT-IV

FACTS Controller for series compensation: Objectives of series compensation, improvements of voltage and transient stability, power oscillation damping, sub synchronous damping, transmittable power and transmittable angle characteristics, control range, conventional power flow models, variable series impedance model, firing angle model, transient stability model, active power flow control using TCSC & SSSC, Application example. **09**

UNIT-V

Unified power flow controller: Basic operating principles, transmission control, independent real and reactive power flow control, power flow models, transient stability model, control structure, basic control system for P and Q control, dynamic performance, Application example. **08**

Text Books:

1. N.G. Hingorani and L. Gyugyi, “Understanding FACTS”, IEEE Press.
2. Y. H. Song and A. T. Johns, “Flexible AC Transmission Systems (FACTS)”, IEEE Press.
3. R. M. Mathur and R. K. Varma, “Thyristor-Based FACTS Controllers for Electrical Transmission Systems”, Wiley-Blackwell Pub.

Reference Books:

1. K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International Pvt. Ltd.
2. V. K. Sood, “HVDC and FACTS controllers: Applications of Static Converters in Power Systems”, Springer.

EE–7041
POWER SYSTEM OPERATION AND CONTROL

L	T	P
3	1	0

UNIT-I

Introduction: Structure of power systems, power system control center, level decomposition in power system, Power system security, various operational stages of power system, power system voltage stability, frequency stability, and rotor angle stability. **08**

UNIT-II

Economic Operation: Concept and problems of unit commitment input-output characteristics of thermal and hydro-plants System constraints, optimal operation of thermal units without and with transmission losses, penalty factor, incremental transmission loss, transmission loss formula (without derivation) Hydrothermal scheduling long and short terms, Concept of optimal power flow. **08**

UNIT-III

Load Frequency Control: Concept of load frequency control, load frequency control of single area system: Turbine speed governing system and modeling, block diagram representation of single area system, steady state analysis, dynamic response, control area concept, P-I control, load frequency control and economic dispatch control.

Load frequency control of two area system: Tie line power modeling, block diagram representation of two area system, static and dynamic Response. **10**

UNIT-IV

Automatic Voltage Control: Schematic diagram and block diagram representation, different types of EEE Excitation systems &their controllers and mathematical modeling.

Voltage and Reactive Power control: Concept of voltage control, methods of voltage control, control by tap changing transformer. Shunt Compensation, series compensation, phase angle compensation, concept of bank of capacitors, bank of inductors. **08**

UNIT-V

State Estimation: Detection and identification, Linear and non-linear models.

Application of power system stabilizers: Basic Concepts of PSS, Control Signals, Structure and tuning of PSS, Field Implementation, PSS Design and Applications, Recent Development and Future Trends. **06**

Text Books:

1. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, Tata McGraw Hill.
2. P. S. R. Murty, “Operation and control in Power Systems”, B. S. Publications.
3. N. G. Hingorani and L. Gyugyi, “Understanding FACTs: Concepts and Technology of Flexible AC Transmission Systems”, Wiley india Pvt. Ltd.
4. A. J. Wood and B.F. Wollenburg, “Power Generation, Operation and Control”, John Wiley & Sons.

Reference Books:

5. O. I. Elgerd, “Electric Energy Systems Theory”, Tata McGraw Hill.
6. P. Kundur, “Power System Stability and Control”, Tata McGraw Hill.
7. M.H. Rashid, “Power Electronics: Circuits, Devices and Applications”, Prentice Hall of India.
8. T. K. Nagsarkar& M. S. Sukhija, “Power System Analysis”, Oxford University Press.

EE–7042
ADVANCED POWER TRANSMISSION

L	T	P
3	1	0

UNIT-I

EHV AC Transmission: Need of EHV transmission, standard transmission voltage, electrical and mechanical considerations of EHV lines, surface voltage gradients in conductor, distribution of voltage gradients on sub-conductors, Features of EHV transmission lines. **08**

UNIT-II

HVDC Transmission: DC links, components and configurations, converter station, operation and controls of converters, characteristics, power control, starting and stopping of dc link. **08**

UNIT-III

Flexible AC Transmission Systems: Fundamentals of ac power transmission, transmission problems and needs, Mechanism of active and reactive power flow control, basic FACTS controllers with application and principles of operation. **08**

UNIT-IV

Introduction to Smart Grid - Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid. **08**

UNIT-V

Power Quality: Overview and definition of power quality, Sources of pollution, power quality disturbances, voltage fluctuations, unbalance waveform distortion, power frequency variations, mitigation and control of power quality issues. **08**

Text Books:

1. R. D.Begmudre, “Extra High Voltage AC Transmission Engineering”, New Age Int. Ltd.
2. K.R. Padiyar, “HVDC Power Transmission System”, New Academic Science Ltd.
3. N. G. Hingorani and L. Gyugyi, “Understanding FACTs: Concepts and Technology of Flexible AC Transmission Systems”, Wiley India Pvt. Ltd.
4. K. S. Manoj, “Smart Grid: Concepts to Design”, Notion Press.

Reference Books;

1. S. Rao, “EHV-AC and HVDC Transmission Engineering & Practice”, Khanna Publishers.
2. E.W. Kimbark, “Direct Current TransmissionVol:1”, Wiley Interscience.
3. Math H. J. Bollen, “Understanding Power Quality Problems:VoltageSags and Interruptions”, Wiley India Pvt. Ltd.
4. Y.-H. Song, A. T. Johns, “Flexible AC Transmission Systems (FACTS)”, IET publication.
5. S. Borlase, “Smart Grids: Infrastructure, Technology, and Solutions”, CRC Press.

EE–7043
APPLICATIONS OF MODERN POWER ELECTRONICS IN POWER SYSTEM

L	T	P
3	1	0

UNIT-I

Applications for reactive power compensation: Analysis of uncompensated AC line, passive reactive power compensation, compensation by a series capacitor connected at the mid-point of the line, effect on power transfer capacity, principles of conventional reactive power compensators, synchronous condenser, saturated reactor, Thyristor-Controlled Reactor (TCR), Fixed Capacitor-Thyristor Controlled Reactor (FC-TCR), Thyristor Switched Capacitor (TSC), Thyristor-Switched Capacitor Thyristor Controlled Reactor (TSC-TCR). **10**

UNIT-II

Static VAR Compensator (SVC) and its Applications: Voltage control by SVC, advantages of slope in dynamic characteristics, influence of SVC on system voltage, design of SVC voltage regulator, modeling of SVC for power flow and transient stability, Applications: Enhancement of transient stability, steady-state power transfer, Enhancement of power system damping, prevention of voltage instability. **08**

UNIT-III

Thyristor Controlled Series Capacitor (TCSC) and its Applications: Operation of TCSC, different modes of operation, modeling of TCSC, variable reactance model, modeling for power flow and stability studies, Applications: Improvement of the system stability limit, enhancement of system damping, SSR mitigation. **08**

UNIT-IV

Voltage Source Converter Based FACTS Controllers: Static Synchronous Compensator (STATCOM), Principle of operation, V-I Characteristics, Applications: Steady state power transfer, Enhancement of transient stability, Prevention of voltage instability, SSSC, Operation of SSSC, Control of power flow, Modeling of SSSC in load flow and transient stability studies, Applications: SSR mitigation, UPFC and IPFC. **08**

UNIT-V

Placement & Co-ordination of FACTS Controllers: Controller interactions, SVC, SVC interaction, co-ordination of multiple controllers using linear control techniques, control coordination using AI-techniques. **06**

Text Books:

1. N. G. Hingorani and L. Gyugyi, "Understanding FACTs: Concepts and Technology of Flexible AC Transmission Systems", Wiley India Pvt. Ltd.
2. Y.-H. Song, A. T. Johns, "Flexible AC Transmission Systems (FACTS)", IET publication.
3. R. M. Mathur and R.K. Varma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", John Wiley & Sons, Inc.

Reference Books:

1. K. R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age Int.Pvt. Ltd.
2. V. K. Sood, "HVDC and FACTS controllers: Applications of Static Converters in Power Systems", Springer.

EE–7044
SCADA AND ENERGY MANAGEMENT

L	T	P
3	1	0

UNIT-I

Supervisory Control and Data Acquisition (SCADA): Introduction to supervisory control and data acquisition, general structure, SCADA functional requirements and components, general features, functions and applications, benefits; Configurations of SCADA, RTU (Remote Terminal Units) connections, various communication channels- cables, telephone lines, power line carrier, microwaves, fiber optical channels and satellites. **10**

UNIT-II

Man- Machine Communication: Power Systems SCADA and SCADA in power system automation, SCADA communication requirements. SCADA communication protocols: Past Present and Future. Structure of SCADA communications protocol, operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities. **10**

UNIT-III

Introduction to Energy Management: Need for energy management, principles of energy management, energy management program, energy policy and planning, energy accounting-energy monitoring, targeting and reporting- energy audit process. **06**

UNIT-IV

Energy Cost and Load Management: Important concepts in an economic analysis, economic models-time value of money-utility rate structures, cost of electricity-loss evaluation. load management: demand control techniques, utility monitoring and control system, energy management, economic justification. **08**

UNIT-V

Energy Management for Machines and Electrical Equipment: Introduction, power supply, power meter, electric motors, transformers, reactors and capacitors, motor efficiency management, motor performance management process. **06**

Text Books:

1. George L. Kusic, "Computer Aided Power System Analysis", Prentice Hall of India,
2. Sunil S Rao, "Switchgear Protection & Control System", Khanna Publishers.
3. B. L. Capehart, W. C. Turner, and W. J. Kennedy, "Guide to Energy Management", Fairmont Press.

Reference Books:

1. https://nptel.ac.in/courses/108106022/11
2. M. S. Thomas and J. D. McDonald, "Power Systems SCADA and Smart Grids", CRC Press.
3. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
4. A. K. Tyagi, "Handbook on Energy Audits and Management", Tata Energy Research Institute, New Delhi.
5. E. Handschinand A. Petroianu, "Energy Management Systems", Springer-Verlag.

AS–701
ENGINEERING ECONOMICS

L	T	P
3	0	0

Unit-1

Introduction of Engineering Economics and Demand Analysis: Meaning and nature of economics, relation between science, engineering, technology and economics; Meaning of demand, determinants of demand, shifts in demand, law of demand, price elasticity of demand &types, income elasticity, cross price elasticity, determinants of elasticity and uses and importance of elasticity. **08**

Unit-2

Concept of Supply: Law of supply, factors affecting supply, and elasticity of supply. Demand forecasting: introduction, meaning and forecasting, methods or techniques of demand forecasting, criteria for good demand forecasting and demand forecasting for a new product. **08**

Unit-3

Cost Analysis: Introduction, types of costs, cost-output relationship: cost function, cost-output relationships in the short run, and cost-output relationships in the long run; Short run and long run, break- even analysis; Production functions: laws of variable proportions, law of returns and economies of scale: internal and external. **08**

Unit-4

Market Structure: Market structure perfect competition, imperfect competition – monopolistic, oligopoly and duopoly sorbent features of price determination and various market conditions. **08**

Unit-5

Nature and characteristics of Indian economy: Concepts of LPG, elementary concepts of national income, inflation and business cycles ,concept of N.I and measurement, meaning of inflation, types and causes and phases of business cycle investment decisions for boosting economy(national income and per capital income). **08**

Text Books:

1. Premvir Kapoor, "Sociology and Economics for Engineers", Khanna Publishing.
2. Salvatore D, “Principles of Microeconomics”, Oxford University Press.
3. Koutsoyiannis A, “Modern Microeconomic”, Macmillan Education Ltd.

Reference Books:

1. Dwivedi DN, “Principles of Microeconomics”, Pearson Education.
2. Cowell, FA, “Microeconomic Principles and Analysis”, Oxford University Press.
3. Riggs J L, “Engineering Economics”, McGraw Hills.

AS–702
INDUSTRIAL MANAGEMENT

L	T	P
3	0	0

Unit-1

Introduction: Concept and scope of industrial management. **Productivity:** definition, measurement, productivity index, types of production system and industrial ownership. **08**

Unit-2

Functions of Management: Taylor's scientific management theory, Fayol's principles of management, social responsibilities of management, introduction to human resources management: nature of HRM, functions and importance of HRM. **08**

Unit-3

Work Study: Introduction, definition, objectives, steps in work study; **Method study:** Definition, objectives, steps of method study; **Work measurement:** Purpose, types of study: Stop watch methods steps: Allowances, standard time calculations, work sampling, production planning and control inventory control: inventory, cost, models of inventory control: EOQ, ABC, VED. **08**

Unit-4

Quality Control: Statistical quality control, control charts for variables and attributes, acceptance sampling: single sampling- double sampling plans and introduction to TQM. **08**

Unit-5

Project Management: Project network analysis, CPM, PERT and project crashing and resource leveling. **08**

Text Books:

1. Gideon Halevi, "Industrial Management- Control and Profit: A Technical Approach" Springer.
2. A.P. Verma and N. Mohan "A Textbook of Industrial Management" S.K. Kataria & Sons.
3. S. K. Sharma, Savita Sharma "Industrial Engineering and Organization Management", Kataria and Sons.

Reference Books:

1. S.C. Sharma & T.R. Banga, "Engineering Management" (Industrial Engineering & Management), Khanna Book Publishing Co.
2. P. Khanna, "Industrial Engineering and Management", Dhanpatrai publications Ltd.
3. Paneer Selvam, "Production & Operation Management", PHI.

EE–751
SWITCHGEAR AND PROTECTION LAB

L	T	P
0	0	2

Note:-At least **ten** experiments are to be conducted from the following list.

1. To study the IDMT Over Current relay and determine the operating characteristics for two time and current settings (Electro-mechanical Type).
2. To study numerical type IDMT Over Current relay with software through pc interfacing.
3. To find the operating characteristics of the Thermal Relay and given Fuse.
4. To study Buchholz Relay.
5. To study numerical type Distance Relay.
6. To study numerical type Differential Relay.
7. To study set up for protection of Alternator.
8. To study set up for protection of 3-phase Transformer.
9. To Study the working Principle of VCB (Vacuum Circuit Breaker) and to test the VCB Under over Current fault and Earth fault conditions.
10. To study the tripping of oil circuit breaker.
11. To study over voltages resulting from switching of transmission lines and limiting them by ZnO arresters.

EE–752
ELECTRIC DRIVES LAB

L	T	P
0	0	2

Note:-At least **ten** experiments are to be conducted from the following list.

Hardware Based Experiments:

1. To study dynamic braking and low voltage plugging of dc shunt motor.
2. To study three phase induction motor braking (a) low voltage plugging (b) low voltage dc dynamic braking (c)capacitor braking.
3. To study speed control of separately excited dc motor by varying armature voltage using single-phase fully controlled bridge converter.
4. To study speed control of separately excited dc motor using MOSFET/IGBT chopper.
5. To study speed control of separately excited dc motor using single-phase dual converter (Static Ward-Leonard Control).
6. To study speed control of single-phase induction motor using single phase ac voltage controller.
7. To study speed control of three-phase induction motor using three-phase ac voltage controller.
8. To study speed control of three-phase induction motor using three-phase voltage source inverter.
9. To study speed control of three-phase induction motor using three-phase current source inverter.
10. To study closed loop control of separately excited dc motor.
11. To study speed control of three-phase slip ring induction motor using static rotor resistance control using rectifier and chopper.
12. To study speed control of three-phase slip ring induction motor using static Scherbius slip power recovery control scheme.

Simulation Based Experiments (using MATLAB or any other software):

13. To study starting transient response of separately excited dc motor
14. To study speed control of separately excited dc motor using single phase fully-half controlled bridge converter in discontinuous and continuous current modes.
15. To study speed control of separately excited dc motor using chopper control in motoring and braking modes.
16. To study starting transient response of three-phase induction motor
17. To study speed control of three phase induction motor using (a) constant V/F control (b) Constant Voltage and frequency control.

EE–753
INDUSTRIAL TRAINING

L	T	P
0	0	2

Students will go Industrial training of four to six weeks in any industry or reputed organization after the VIth semester examination in summer. They will also prepare an exhaustive technical report of the training which will be duly signed by the officer under whom training was taken in the industry/organization. They will have to give presentation about the training before a committee consisting of faculty members constituted by the concerned Head of the Department.

EE–754
PROJECT (PHASE-I)

L	T	P
0	0	3

Project shall be assigned to the students at the start of VIIth semester. There should not usually be more than 3 students in a batch. The project should be based on latest technology as far as possible and it may be hardware or/and software based. The assessment of performance of students should be made at least twice in the semester. Students should be encouraged to present their progress of project using LCD projector.

EE–8011
SMART GRID

L	T	P
3	1	0

UNIT-I

Introduction to Smart Grid: Evolution of Electric Grid, Need for smart grid, difference between conventional & smart grid, overview of enabling technologies, international experience in smart grid deployment efforts, smart grid road map for INDIA, smart grid architecture. **08**

UNIT-II

Wide Area Monitoring System: Fundamentals of synchro phasor technology, concept and benefits of wide area monitoring system, structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC), Road Map for synchro phasor applications (NAPSI), operational experience and blackout analysis using PMU. **08**

UNIT-III

Smart Meters: Features and functions of smart meters, functional specification, category of smart meters, AMR and AMI drivers and benefits, AMI protocol, Demand Side Integration-Peak load, Outage and Power Quality management **08**

UNIT-IV

Information and Communication Technology: Overview of smart grid communication system, modulation and demodulation techniques, radio communication, mobile communication, power line communication, optical fiber communication, communication protocol for smart grid. **08**

UNIT-V

Smart Grid Applications: Overview and concept of renewable integration, role of protective relaying in smart grid, House Area Network, Advanced Energy Storage Technology - Flow battery– Fuel cell–SMES–Super capacitors, Plug–in Hybrid electric Vehicles, Cyber Security requirements, Smart grid information model. **08**

Text Books:

1. D.P. Kothari, S. Sen, "Smart Grid Fundamentals and Applications", New Age International.
2. K.S. Manoj, "Smart Grid - Concepts to Design", Notion Press.
3. B. Modi and A. Prakash "Fundamentals of Smart Grid Technology", S.K. Kataria & Sons.

Reference Books:

1. J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama, N. Jenkins, "Smart Grid Technology and Applications", John Wiley& Sons Publication.
2. "Smart Grid Primer", Power Grid Corporation of India Limited, September 2013.
3. F. P. Sioshansi, "Smart Grid – Integrating Renewable, Distributed and Efficient Energy", Academic Press.

EE–8012
POWER SYSTEM PLANNING AND RELIABILITY

L	T	P
3	1	0

UNIT-I

Introduction: Objectives of planning, long and short term planning, planning of generation, transmission and distribution systems. Least Cost Power Planning, integration of DSM. **06**

UNIT-II

Load Forecasting: Classification and characteristics of loads, approaches to load forecasting, Forecasting methodology: short-run and long run forecasting, energy forecasting, peak demand forecasting, total forecasting, annual and monthly peak demand forecasting, electricity price forecasting. **08**

UNIT-III

Basic Reliability Concepts: General reliability function, exponential distributions, meantime to failure, Markov Chains and processes and their applications, simple series and parallel system models. **06**

UNIT-IV

Static Generating Capacity Reliability Evaluation: Outage definitions, loss of load probability methods, loss of energy probability method, frequency and duration methods, load forecasting uncertainty.

Spinning Generating Capacity Reliability Evaluation: Spinning capacity evaluation, load forecast uncertainty. **10**

UNIT-V

Transmission System Reliability Evaluation: Average interruption rate method, Loss of Load Probability (LOLP) method, the frequency and duration method.

Inter-connected Systems Generating Capacity Reliability Evaluation: Introduction, loss of load approach; Interconnection benefits; Reliability evaluation in two and more than two interconnected systems.

Distribution System Reliability Analysis: Distribution network reliability, reliability performance.**10**

Text Books:

1. Roy Billinton and R. N. Allan, “Reliability Evaluation of Power Systems”, Springer India.
2. A.A. Chowdhury and D. O. Koval, “Power Distribution System Reliability: Practical Methods and Applications”, Wiley-IEEE Press.

Reference Books:

1. D. Elmakias, “New Computational Methods in Power System Reliability”, Springer-Verlag Berlin Heidelberg.
2. J. Endrenyi, “Reliability Modelling in Electric Power System”, John Wiley.

EE–8013
EHV AC AND DC TRANSMISSION

L	T	P
3	1	0

UNIT-I

Introduction to EHV AC and DC systems: Need of EHV transmission, standard transmission voltage, comparison of EHV AC & DC transmission systems and their applications & limitations, surface voltage gradients in conductor, distribution of voltage gradients on sub-conductors, mechanical considerations of transmission lines, modern trends in EHV AC and DC transmission **08**

UNIT-II

Phenomenon in EHV AC Transmission: Corona loss formulas, corona current, audible noise – generation and characteristics corona pulses their generation and properties, radio interference (RI) effects, over voltage due to switching, Ferro-resonance, reduction of switching surges on EHV system, principle of half wave transmission. **08**

UNIT-III

Testing in Extra High Voltage: Characteristics and generation of impulse voltage, generation of high AC and DC voltages, measurement of high voltage by sphere gaps and potential dividers. Consideration for Design of EHV Lines: Design factors under steady state limits, EHV line insulation design based upon transient over voltages. **08**

UNIT-IV

EHV DC Transmission: Types of dc links, converter station, choice of converter configuration and pulse number, effect of source inductance on operation of converters. Principle of DC link control, converter controls characteristics, firing angle control, current and excitation angle control, power control, starting and stopping of DC link. **06**

UNIT-V

Analysis of EHV DC Transmission: Converter faults, protection against over currents and over voltages, smoothing reactors, generation of harmonics, AC and DC filters,

Multi Terminal DC systems (MTDC): Types, control, protection and applications. **10**

Text Books:

1. R. D. Begamudre, “Extra High Voltage AC Transmission Engineering” New Age International.
2. K. R. Padiyar, “HVDC Power Transmission Systems: Technology and System Reactions” New Age International.
3. S. Rao, “EHV AC and HVDC Transmission Engineering and Practice” Khanna Publisher.

Reference Books:

1. J. Arrillaga,“High Voltage Direct current Transmission” IET Press.
2. M. H. Rashid, “Power Electronics: Circuits, Devices and Applications” Prentice Hall of India.
3. M. S. Naidu and V. Kamaraju, “High Voltage Engineering” Tata McGraw Hill.

EE–8014
POWER QUALITY

L	T	P
3	1	0

UNIT-I

Power Quality Terms and Definitions: Introduction, transients; Short Duration Voltage Variations: Interruption, sag, swell; Long Duration Voltage Variations: Under voltage, over voltage and sustained interruptions; Voltage and Phase Imbalance; waveform distortion; voltage fluctuation; power frequency variations, harmonics, frequency deviation monitoring. Power Quality Problems: Poor load power factor, load containing harmonics, notching in load voltage, DC offset in loads, unbalanced loads, and disturbance in supply voltage. **08**

UNIT-II

Voltage Sag: Sources of voltage sag: motor starting, arc furnace, fault clearing etc; estimating voltage sag performance and principle of its protection; solutions at end user Level- Isolation Transformer, Voltage Regulator, Static UPS, Rotary UPS, Active Series Compensator. **08**

UNIT-III

Electrical Transients: Sources of Transient Over Voltages-Atmospheric and switching transients-motor starting transients, power factor correction capacitor switching transients, ups switching transients, neutral voltage swing etc; devices for over voltage protection. **06**

UNIT-IV

Harmonics: Causes of harmonics; current and voltage harmonics: measurement of harmonics; effects of harmonics on-Transformers, AC motors, capacitor banks, cables, and protection devices, energy metering, communication lines etc., harmonic mitigation techniques. **08**

UNIT-V

Monitoring Power Quality: Power quality related standards, standard test waveforms, and detailed power quality monitoring; Power quality measurement devices: Harmonic analyzer, Transient Disturbance Analyzer, wiring and grounding tester, flicker meter, oscilloscope, multimeter etc.

Custom Power Devices: Utility customer interface, network reconfiguration devices; Load compensation and voltage regulation using D-STATCOM; protecting sensitive loads using Dynamic Voltage Restorer (DVR); Unified Power Quality Conditioner (UPQC). **10**

Text Books:

1. R. C. Dugan, M.F. McGranaghan, S. Santoso & H.W. Beaty, “Electrical Power System Quality”, Tata McGraw Hill.
2. A. Ghosh & G.Ledwich, “Power Quality Enhancement Using Custom Power Devices”, Springer US.
3. C. Sankaran, “Power Quality”, CRC Press.

Reference Books:

1. G. T. Heydt, “Electric Power Quality”, Stars in a Circle Publications.
2. G. J. Porter and J. A. V. Sciver, “Power Quality Salutations: Case Study for Troubleshooters”, Fairmont Press.

EE–802
INSTRUMENTATION AND PROCESS CONTROL

L	T	P
3	1	0

UNIT-I

Transducer-I: Definition, advantages of electrical transducers, classification, characteristics, factors affecting the choice of transducers, potentiometers, strain gauges, resistance thermometer, thermistors, thermocouples, LVDT, RVDT. **08**

UNIT-II

Transducer-II: Capacitive, Piezoelectric Hall Effect and opto electronic transducers; Measurement of motion, Force pressure, temperature, flow and liquid level. **06**

UNIT-III

Telemetry: General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter. Data Acquisition System: Analog data acquisition system, digital data acquisition system, modern digital data acquisition system. **09**

UNIT-IV

Display Devices and Recorders: Display devices, storage oscilloscope, spectrum analyzer, strip chart & x-y recorders, magnetic tape &digital tape recorders. Recent Developments: Computer aided measurements, fiber-optic transducers, micro-sensors, smart sensors, and smart transmitters. **07**

UNIT-V

Process Control: Principle, elements of process control system, process characteristics, proportional (P), integral (I), Derivative (D), PI, PD and PID control modes; Electronic, Pneumatic & digital controllers. **09**

Text Books:

1. A. K. Sawhney, "Advanced Measurements & Instrumentation", Dhanpat Rai & Sons.
2. B. C. Nakra and K. K. Chaudhry, "Instrumentation, Measurement and Analysis", Tata McGraw Hill.
3. C. D. Johnson, "Process Control Instrumentation Technology", Pearson.

Reference Books:

1. E.O. Doebelin, "Measurement Systems – Application and design", McGraw Hill.
2. W. D. Cooper and A. D. Helfrick, "Electronics Instrumentation and Measurement Techniques", Prentice Hall International.

AS–801
ENGINEERING ECONOMICS

L	T	P
3	0	0

Unit-1

Introduction of Engineering Economics and Demand Analysis: Meaning and nature of economics, relation between science, engineering, technology and economics; Meaning of demand, determinants of demand, shifts in demand, law of demand, price elasticity of demand &types, income elasticity, cross price elasticity, determinants of elasticity and uses and importance of elasticity. **08**

Unit-2

Concept of Supply: Law of supply, factors affecting supply, and elasticity of supply. Demand forecasting: introduction, meaning and forecasting, methods or techniques of demand forecasting, criteria for good demand forecasting and demand forecasting for a new product. **08**

Unit-3

Cost Analysis: Introduction, types of costs, cost-output relationship: cost function, cost-output relationships in the short run, and cost-output relationships in the long run; Short run and long run, break- even analysis; Production functions: laws of variable proportions, law of returns and economies of scale: internal and external. **08**

Unit-4

Market Structure: Market structure perfect competition, imperfect competition – monopolistic, oligopoly and duopoly sorbent features of price determination and various market conditions. **08**

Unit-5

Nature and characteristics of Indian economy: Concepts of LPG, elementary concepts of national income, inflation and business cycles ,concept of N.I and measurement, meaning of inflation, types and causes and phases of business cycle investment decisions for boosting economy(national income and per capital income). **08**

Text Books:

1. Premvir Kapoor, "Sociology and Economics for Engineers", Khanna Publishing.
2. Salvatore D, “Principles of Microeconomics”, Oxford University Press.
3. Koutsoyiannis A, “Modern Microeconomic”, Macmillan Education Ltd.

Reference Books:

1. Dwivedi DN, “Principles of Microeconomics”, Pearson Education.
2. Cowell, FA, “Microeconomic Principles and Analysis”, Oxford University Press.
3. Riggs J L, “Engineering Economics”, McGraw Hills.

AS–802
INDUSTRIAL MANAGEMENT

L	T	P
3	0	0

Unit-1

Introduction: Concept and scope of industrial management. **Productivity:** definition, measurement, productivity index, types of production system and industrial ownership. **08**

Unit-2

Functions of Management: Taylor's scientific management theory, Fayol's principles of management, social responsibilities of management, introduction to human resources management: nature of HRM, functions and importance of HRM. **08**

Unit-3

Work Study: Introduction, definition, objectives, steps in work study; **Method study:** Definition, objectives, steps of method study; **Work measurement:** Purpose, types of study: Stop watch methods steps: Allowances, standard time calculations, work sampling, production planning and control inventory control: inventory, cost, models of inventory control: EOQ, ABC, VED. **08**

Unit-4

Quality Control: Statistical quality control, control charts for variables and attributes, acceptance sampling: single sampling- double sampling plans and introduction to TQM. **08**

Unit-5

Project Management: Project network analysis, CPM, PERT and project crashing and resource leveling. **08**

Text Books:

1. Gideon Halevi, "Industrial Management- Control and Profit: A Technical Approach" Springer.
2. A.P. Verma and N. Mohan "A Textbook of Industrial Management" S.K. Kataria & Sons.
3. S. K. Sharma, Savita Sharma "Industrial Engineering and Organization Management", Kataria and Sons.

References Books:

1. S.C. Sharma & T.R. Banga, "Engineering Management" (Industrial Engineering & Management), Khanna Book Publishing Co.
2. P. Khanna, "Industrial Engineering and Management", Dhanpatrai publications Ltd.
3. Paneer Selvam, "Production & Operation Management", PHI.

EE–851
INSTRUMENTATION AND PROCESS CONTROL LAB

L	T	P
0	0	2

Note:-At least **ten** experiments are to be conducted from the following list.

1. Measurement of displacement using LVDT.
2. Measurement of displacement using strain gauge based displacement transducer.
3. Displacement measurement with the help of light dependent resistor.
4. Measurement of displacement using inductive pick up transducer.
5. Measurement of load using strain gauge based load cell.
6. Measurement of liquid level using capacitive type transducer.
7. Measurement of flow rate by anemometer.
8. Measurement of temperature using thermocouple.
9. Measurement of speed of motor using photo electric pickup transducer.
10. Measurement of vibration using piezo electric transducers.
11. Design and test a signal conditioning circuit for any transducer.
12. Determination of characteristics of a solid state sensor/fiber-optic sensor.
13. Study of pH control test rig.

Simulation Based Experiments (using LABVIEW or any other software):

14. Study of data acquisition system using **"labview"** software and test all signal points.
15. Measurement of sine, triangular,square wave signal of function generator and verify its frequency at 100 Hz tap point using **"labview"** software.
16. Measurement of voltage and current signal of programmable power supply using **"labview"** GPIB interface.

EE–852
PROJECT (PHASE-II)

L	T	P
0	0	12

Students should devote themselves to expedite progress of the project as soon as VIIIth semester starts. They are supposed to finish project work latest by middle of April and submit project report by the end of the April month. The assessment of performance of students should be made at least twice in the semester. The students should present project using power point presentation in the end semester project examination.