**INTEGRAL UNIVERSITY LUCKNOW**

**Study & Evaluation Scheme**

**B. Tech. (Electrical Engg.)**

**Year 4th, Semester-VII**

| S. No. | Subject Code | Category | Subject | Periods | | | | Evaluation Scheme | | | | Subject Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Sessional | | | Exam. | |
| | | | | L | T | P | C | CT | TA | Total | ESE | |
| **Theory Subjects** | | | | | | | | | | | | |
| 1. | EE401 | DC | Power System Protection | 3 | 1 | 0 | 4 | 25 | 15 | 40 | 60 | 100 |
| 2. | EE403 | DC | Electric Drives | 3 | 1 | 0 | 4 | 25 | 15 | 40 | 60 | 100 |
| 3. | | DE | Departmental Elective –IX | 3 | 1 | 0 | 4 | 25 | 15 | 40 | 60 | 100 |
| 4. | | DE | Departmental Elective –X | 3 | 1 | 0 | 4 | 25 | 15 | 40 | 60 | 100 |
| 5. | | DE | Departmental Elective –XI | 3 | 1 | 0 | 4 | 25 | 15 | 40 | 60 | 100 |
| 6. | EE402 | DC | Power System Protection Lab | 0 | 0 | 2 | 1 | 30 | 30 | 60 | 40 | 100 |
| 7. | EE404 | DC | Electric Drive Lab | 0 | 0 | 2 | 1 | 30 | 30 | 60 | 40 | 100 |
| 8. | EE499 | DC | B.Tech. Project | 0 | 0 | 2 | 1 | - | 100 | 100 | - | 100 |
| 9. | *EE300 | | Industrial Training | - | - | - | - | - | 50 | 50 | - | 50 |
| | | | **Total** | **14** | **5** | **8** | **23** | **215** | **235** | **420** | **380** | **800** |

Industrial Training (EE-300) is compulsory during summer vacation of third year in which a student must obtain 50% passing marks. These marks will not be included in result.

ecture **T-T**utorial **P-**Practical **C**-Credits **CT-**Class Test **TA-**Teacher Assessment

**Sessional Total (CA)** = Class Test + Teacher Assessment

**Subject Total** = Sessional Total (CA) + End Semester Examination (ESE)

**BS-** Basic Science **DC-** Departmental Core **HM-** Humanities **OE-** Open Elective

**DE-** Departmental Elective **ESA-** Engineering Sciences & Arts (Foundation Course & Engineering Courses)

**Departmental Elective –IX**

| | | |
|---|---|---|
| 1. | Electrical Insulation in Power Apparatus & System | EE-421 |
| 2. | Application of Power Electronics to Power System | EE-423 |
| 3. | EHVAC & EHVDC Transmission | EE-425 |
| 4. | Power System Dynamics | EE-427 |
| 5. | DSP and its application | EE-429 |

**Departmental Elective – X**

| | | |
|---|---|---|
| 1. | Utilization of Electrical Energy & Traction | EE-431 |
| 2. | Power Quality & Mitigation | EE-433 |
| 3. | High Voltage DC Transmission | EE-435 |
| 4. | Electrical Distribution System & Automation | EE-437 |
| 5. | High Power Semiconductor Devices | EE-439 |

**Departmental Elective –XI**

| | | |
|---|---|---|
| 1. | Flexible AC Transmission System | EE-441 |
| 2. | Special Electric Machines | EE-443 |
| 3. | Electrical System and Substation Design | EE-445 |
| 4. | Electric Vehicles | EE-447 |
| 5. | Energy Conservation &Energy Audit | EE-449 |

**EE401/EEE401 POWER SYSTEM PROTECTION**

(w. e. f. Session 2018-19)

**L T P C**
**3 1 0 4**

**Pre-requisites:** None **Co-requisites:** None

**Unit-1**

**Introduction to power system:** Introduction to protective system and its elements, Function of protective relaying, Protective zones, Primary and backup protection, Desirable qualities of protective relaying, Basic terminology.

**Relays**: Electromagnetic, Attraction and induction type relays; Thermal relay; Gas actuated relay (8)

**Unit-2**

**Relay Applications and characteristics:** Amplitude and phase comparators, Over-current relays, Directional relays, Distance relays, Differential relays.

**Static relays:** Comparison with electromagnetic relays, Classification and their description, Over-current relays, Directional relays, Distance relays, Differential relays (8)

**Unit-3 Protection of transmission line**

Time graded protection; Differential and distance protection of feeders; Choice between impedance, reactance and MHO relays; Elementary idea about carrier current protection of lines; Protection of bus; Auto reclosing, Pilot wire protection (8)

**Unit-4**

**Circuit Braking:** Arc phenomenon, Properties of arc, Arc extinction theories, Recovery voltage and re-striking voltage, Current chopping, Resistance switching, Capacitance current interruption, Circuit breaker ratings.

**Circuit breakers**: Need of circuit breakers; Types of circuit breakers; Operating modes; Principles of construction; Details of Air Blast, Bulk Oil, Minimum Oil, SF6, Vacuum Circuit Breakers, DC circuit breakers. (8)

**Unit-5 Apparatus protection**

Types of faults on alternator, Stator and rotor protection, Negative sequence protection, Loss of excitation and overload protection, Types of fault on transformers, Percentage differential protection, Isolated neutral system, Grounded neutral system and selection of neutral grounding (8)

**References:**


1. S. S. Rao, "Switchgear and Protection", Khanna Publishers, 13th Edition, 2008.
2. B. Ravindranath and M. Chander, "Power system Protection and Switchgear", Wiley Eastern Ltd., 5th Edison, 2015.
3. B. Ram and D. N. Vishwakarma, "Power System Protection and Switchgear", Tata McGraw Hill, 2nd Edition, 2011.
4. Y. G. Paithankar and S R Bhide, "Fundamentals of Power System Protection", Prentice Hall of India, 2004.
5. T.S.M. Rao, "Power System Protection: Static Relays with Microprocessor Applications", Tata McGraw Hill, 2nd edition, 1993.

**EE403/EEE403 ELECTRIC DRIVES**

(w. e. f. Session 2018-19)

**L T P C**
**3 1 0 4**

**Pre requisite: None** **Co requisites- None**

**Unit-1 Fundamentals of Electric Drive**

Electric drives and its parts, Advantages of electric drives, Classification of electric drives Speed-torque conventions and multi-quadrant operations constant torque and constant power operation, Types of load torque: Components, Nature and Classification. (8)

**Unit-2 Dynamics of Electric Drive**

Dynamics of motor-load combination; Steady state stability of Electric Drive; Transient stability of electric drive; 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; Load equalization. (8)

**Unit-3 Electric Braking**

Purpose and types of electric braking; Braking of dc, three phase induction and synchronous motors; Dynamics during starting and braking of dc motors; Calculation of acceleration time and energy loss during starting of dc shunt and three phase induction motors; Methods of reducing energy loss during starting; Energy relations during braking, Dynamics during braking of ac motors. (8)

**Unit-4 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; Rectifier control of dc series motor; Supply harmonics, power factor and ripples in motor current; Chopper control of separately excited dc motor and dc series motor. (8)

**Unit-5 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 drives; Special drives: Switched reluctance motor, Brushless dc motor: Selection of motor for particular applications. (8)

**References:**


1. G.K. Dubey, "Fundamentals of Electric Drives", Narosa publishing House, Reprint 2017.
2. S.K. Pillai, "A First Course on Electric Drives", Wiley Eastern Limited, 2nd Edition, 1989.
3. M. Chilkin, "Electric Drives", Mir Publishers, Moscow,1st Edition, 2002.
4. Mohammed A. El-Sharkawi, "Fundamentals of Electric Drives", Thomson Asia, Pvt. Ltd. Singapore, 1st Edition, 2000.
5. N.K. De and Prashant K. Sen, "Electric Drives", Prentice Hall of India Ltd., 1st Edition,2006.
6. V. Subrahmanyam, "Electric Drives: Concepts and Applications", Tata McGraw Hill., 2nd Edition, 2006.

**EE421/ EEE421 ELECTRICAL INSULATION IN POWER APPARATUS AND SYSTEM**

(w. e. f. Session 2018-19)

**L T P C**

**3 1 0 4**

**Pre-requisites:** None **Co-requisites:** None

**Unit-1 Break Down In Insulation**

**Break Down In Gases:** Ionization processes, Townsend's criterion, Breakdown in electronegative gases, Time lags for breakdown, Streamer theory, Paschen's law, Breakdown in non- uniform field, Breakdown in vacuum.

**Break Down In Liquid Dielectrics:** Classification of liquid dielectric, Characteristics of liquid dielectric, Breakdown in pure liquid and commercial liquid.

**Break Down In Solid Dielectric:** Intrinsic breakdown, Electro-mechanical breakdown, Breakdown of solid dielectric in practice, Breakdown in composite dielectrics. (8)

**Unit-2 Generation of High Voltage and Currents**

Generation of High direct Current Voltage, Generation of high alternating voltages, Generation of impulse voltages, Generation of impulse currents, Tripping and control of impulse generators (8)

**Unit-3 Measurement of High Voltage and Currents**

Measurement of High direct Current Voltages; Measurement of High alternating & Impulse voltages; Measurement of High direct, alternating & Impulse Currents; Cathode ray oscillographs for impulse voltage and current measurements. (8)

**Unit-4 Over Voltage Phenomenon & Insulation Coordination**

Lighting Phenomenon as natural cause for over voltage, Overvoltage due to switching surges and abnormal conditions, Principal of insulation coordination (8)

**Unit-5 Non -Destructive Insulation Test Techniques**

Dynamic properties of dielectrics, Measurement of direct current resistively, Measurement of dielectric constant and loss factor, Partial discharge measurements. (8)

**References:**


1. E. Kuffel, W.S. Zaengl and J. Kuffel, "High Voltage Engineering", CBS Publishers New Delhi, 2nd Edition, 2005.
2. M.S. Naidu & V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill, 5th edition, 2013.
3. C.L. Wadhwa, "High Voltage Engineering", New Age Internationals (P) Limited, 3rd Edition, 2010.
4. M. Khalifa, "High Voltage Engineering: Theory and Practice", Marcel Dekker, 1st edition, 1990.
5. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India, 2nd edition, 2013.

**EE423/ EEE423 APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS**

**(w.**e.f. session: 2018-19)

**L T P C**
**3 1 0 4**

**Pre requisite: Power Electronics (EE-303)** **Co-Requisite: None**

**UNIT-1 Steady State and Dynamic Problems in AC System**

Steady state and dynamic problems in AC systems; Flexible AC transmission systems (FACTS); Basic types of FACTs controllers; Shunt, series, combined shunt and series connected controller. (8)

**UNIT-2 FACTS Devices**

Static phase shifters (SPS), Static Condenser (STATCOM), Static synchronous series compensator (SSSC) and unified power flow controller (UPFC). (8)

**UNIT-3 Modeling of FACTS**

Modeling and Analysis of FACTS controllers, Control strategies to improve system stability (8)

**UNIT-4 Power Quality Issues**

Power Quality problems in distribution systems, Harmonics, Harmonics creating loads, Modeling, Harmonic propagation, Series and parallel resonances, Harmonic power flow (8)

**UNIT-5 Mitigation of Power Quality Problem**

Mitigation of harmonics; Filters; Passive filters; Active filters; Shunt, series hybrid filters; Voltage sags & swells; Voltage flicker; Mitigation of power quality problems using power electronics conditioners; WEEE standards (8)

**References:**


1. Narain G.Hingorani, Laszio, Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi, 2001.
2. G.T. Heydt, "Electric Power Quality", Stars in a circle publication, Indiana, 1994
3. T.J.E. Miller, "Static Reactive power compensation", John Wiley & Sons, New York, 1982.
4. C. Sankaran, "Power Quality", CRC press, 2017

**EE425/EEE425 EHVAC & EHVDC TRANSMISSION**

(w. e. f. Session 2018-19)

**L T P C**
**3 1 0 4**

**Pre-requisites:** None **Co-requisites:** None

**UNIT-1 Introduction**

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 (8)

**UNIT-2 EHV AC Transmission**

Corona loss formula, 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. (8)

**UNIT-3**

**Consideration for Design of EHV Lines:** Design factors under steady state limits, EHV line insulation design based upon transient over voltages, Effects of pollution on performance of EHV lines.

**Converter Circuits:** 1-phase and 3-phase converters (properties and configurations), Cascade of converters (8)

**UNIT-4 EHV DC Transmission–I**

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 (8)

**UNIT-5 EHV DC Transmission–II**

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. (8)

**References:**


1. R. D. Begamudre, "Extra High Voltage AC Transmission Engineering", Wiley Eastern, 3rd edition, 2006.
2. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Reactions", New Age International, 2nd edition, 1983.
3. M. S. Naidu & V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill, 3rd edition, 2004.
4. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Prentice Hall of India, 4th edition, 2014.
5. S. Rao, "EHV AC and HVDC Transmission Engineering and Practice", Khanna Publisher, 4th edition, 2011.

**EE427/EEE427 POWER SYSTEM DYNAMICS**

(w. e. f. Session 2018-19)

**L T P C**

**3 1 0 4**

**Pre requisite: Power System-II (EE-311)** **Co requisites- None**

**Unit-1 Power System Dynamics Problems**

Introduction, General basic concept of Power System Stability, States of operation & System Security, System Dynamics Problems, Review of Classical Model, System Model, Analysis of Steady State Stability & Transient Stability (8)

**Unit-2 Modelling of Synchronous Machine**

Introduction, System Simulation, Park's Transformation, Analysis of Steady State Performance, P. U. Quantities and Equivalent Circuit of Synchronous Machine. (8)

**Unit-3 Excitation systems & Prime Mover Controllers**

Simplified Representation of Excitation Control, Excitation systems, Modelling, Standard Block Diagram, State Equations, Prime Mover Control System, Transmission Line & Load Modelling (8)

**Unit-4 Dynamics of Synchronous Generator Connected to Infinite Bus**

System Model, Stator Equation, Rotor equations, Application of Model 1.1, Network Equation, Calculation of Initial Conditions, System Simulation Small Signal Analysis with Block Diagram Representation for Single Machine System, Synchronizing & Damping Torque Analysis, State Equation (8)

**Unit-5 Modelling and Analysis of Transient and Voltage Stability**

Simulation for Transient Stability Evaluation; Application of energy functions for direct stability evaluation; Voltage Stability: Introduction, Factors affecting voltage collapse, Analysis and comparison with angle stability. (8)

**References:**


1. K. R. Padiyar, "Power System Dynamics: Stability & Control", BS Publications, 2nd edition, 2002
2. I. J. Nagrath and M. Gopal, **"**Control system engineering**",** Wiley Eastern Ltd, 3rd edition, 2000.
3. Benjamin C. Kuo, **"**Automatic Control system**",** Prentice Hall of India Pvt. Ltd, 8th edition, 2003.
4. Prabha Kundur, **"**Power System Stability and Control**"**, Tata McGraw Hill, 5th edition, 2014

**EE429/EEE429 DSP & IT'S APPLICATION**
**(w.e.f. session 2018-19)**

**L T P C**
**3 1 0 4**

**Pre-requisites:** None **Co- requisites:** None

**UNIT-1**
**Digital Signals and Systems:** Z-transform, Linear convolution, Linear constant coefficient difference equation, Frequency domain representation of discrete time signals and systems
**The Discrete Fourier Transform and Fast Fourier Transform**: DTFT, DFT and FFT using radix-2 decimation in time and decimation in frequency Algorithms. (8)

**UNIT-2 Filter Design Techniques**
Design of IIR Digital Filter from analog filters by approximation of derivatives, Impulse invariant technique and bilinear transformation techniques, Design of FIR filters by windowing technique, Realization of digital filters using direct form I & II technique (8)

**UNIT-3 Multi-rate Signal Processing**
Introduction of multi-rate signal processing, Decimation, Interpolation, Sampling rate conversion by rational factor, Poly-phase decomposition of LTI system (8)

**UNIT-4 Application of DSP**
Speech signal processing, Image signal processing, Missile guidance and radar system. (8)

**UNIT-5 Digital Signal Processor**
Introduction of Digital Signal Processor, Pipelining, Multiplier accumulator (MAC), Harvard DSP architecture, TMS32010 DSP Processor (8)

**References:**

1. John Proakis and Manolakis, "Digital Signal Processing", Prentice Hall of India Pvt. Ltd., 2016.
2. A.V. Oppenheim, Schafer, Buck, "Discrete – time signal processing", Pearson Prentice Hall, 3rd edition, 2009.
3. A.V.Oppenheim, Willisky, "Signals and Systems", Prentice Hall of India Pvt. Ltd., 2016.
4. Sanjit Mitra, "Digital Signal Processing", 4th edition, McGraw-Hill, New York, NY 2011
5. Hamid Toliyat and Steven Campbell, "DSP Based Electromechanical Motion Control", CRC Press, 2003
6. Sen, M. Kuo, Woon-SengGan, "Digital Signal Processors - Architectures, Implementations, and Applications", Prentice Hall, 2013

**EE431/EEE431 UTILIZATION OF ELECTRICAL ENERGY AND TRACTION**

**(w.**e.f. session: 2018-19)

**L T P C**
**3 1 0 4**

**Pre-requisite: None** **Co-requisite: None**

**Unit-1 Electric Heating**

Advantages and methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating (8)

**Unit-2**

**Electric Welding:** Electric Arc Welding, Electric Resistance welding, Electronic welding control
**Electrolyte Process:** Principles of electro-deposition, Laws of electrolysis, Applications of electrolysis (8)

**Unit-3**

**Illumination:** Various definitions, Laws of illumination, Requirements of good lighting, Design of indoor lighting and outdoor lighting systems.
**Refrigeration and Air Conditioning:** Refrigeration systems, Domestic refrigerator, Water cooler, Types of air conditioning, Window air conditioner (8)

**Unit-4 Electric Traction - I**

Types of electric traction; Systems of track electrification; Traction mechanics - Types of services, Speed time curve and its simplification, Average and schedule speeds; Tractive effort; Specific energy consumption; Mechanics of train movement; Coefficient of adhesion and its influence. (8)

**Unit-5 Electric Traction – II**

Salient features of traction drives, Series – parallel control of dc traction drives (Bridge transition) and energy saving Power Electronic control of dc and ac traction drives, Diesel electric traction. (8)

**Reference Books:**


1. H. Partab, "Art and Science of Electrical Energy", Dhanpat Rai & Sons, 2014
2. G.K. Dubey, "Fundamentals of Electric Drives", Narosa Publishing House, 2nd edition, 2015.
3. H. Partab, "Modern Electric Traction", Dhanpat Rai & Sons, 2013
4. C.L. Wadhwa, " Generation, Distribution and Utilization of Electrical Energy", New Age International Publications, 3rd edition, 2010
5. E. Open Shaw Taylor, "Utilization of Electric Energy", Orient Longman, Reprint 2011.

**EE433/ EEE433 POWER QUALITY AND MITIGATION**

(w. e. f. Session 2018-19)

**L T P C**

**3 1 0 4**

**Pre-requisites:** Power Electronics (EE-303) **Co-requisites:** None

**Unit I Introduction to Power Quality**

Definitions of various powers; Power factor and other figures of merit under balanced, unbalanced and non-sinusoidal conditions (8)

**Unit-II Power Quality issues**

Genesis of power quality problem; Effects on power system; Remedies; Power Quality Standards; Power Frequency Disturbance: Common power frequency disturbances, voltage sags, cures of low frequency disturbances, voltage tolerance. (8)

**Unit-III Harmonics**

Definition, Number, Odd and even harmonics, Causes of harmonics, Individual & total distortion, Harmonics signatures, Effect of harmonics, Guide lines for harmonic voltage & current limitation, Harmonic current mitigation. (8)

**Unit-IV Power Factor**

Introduction, Active and Reactive power, Displacement and true power factor, Power factor improvement, Correction, Penalty, Voltage rise due to capacitance, Application of synchronous condensers and static VAR compensators. (8)

**Unit-V Power Quality Measurement**

Power quality measurement devices, Power quality measurements, Compensators to mitigate power quality related problems. (8)

**References:**


1. A. Ghosh and G. Ledwich, "Power quality enhancement using custom power devices", Kluwer Academic Publication, 2002.
2. C. Shankran, "Power quality", CRC Press, 2001.
3. Angelo Baggini, "Handbook of power quality", John Wiley & Sons, 2008.
4. Roger C. Dugan, "Electrical power systems quality", Tata McGraw-Hill, 2012.
5. H. Akagi, "Instantaneous power theory and application to power conditioning", IEEE Press, 2013.
6. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques", Willey Publication, 1st Edition, Kindle Edition, 2015.

**EE435/EEE435 HIGH VOLTAGE DC TRANSMISSION**

(w.e.f. session 2018-19 )

**L T P C**
**3 1 0 4**

**Pre-requisites:** Power system I EE307, Power Electronics. EE-303 **Co-requisites:** None

**UNIT 1 General Aspects of HVDC Transmission**

Introduction to HVDC Transmission, Comparison of HVAC and HVDC systems (Economics of power transmission, Technical Performance and Reliability), Type of HVDC Transmission systems, Description of HVDC transmission system (Types of DC Links and Converter), Planning for HVDC transmission, Modern trends in HVDC technology (8)

**UNIT 2 Converters**

Simple rectifier circuits, Rectification circuits for HVDC transmission, HVDC converters (Line commutated and Voltage Source converters), Analysis of Graetz Bridge with and without overlap, Pulse number, 12 pulse firing schemes (8)

**UNIT 3 HVDC System Control**

HVDC system control (Principles of DC link control, Firing Angle Current and extinction angle control), Converter mal-operations, Commutation failure, Converter control characteristics, Power Control, Starting and stopping of converter bridge, Converter protection, DC Breakers. (8)

**UNIT 4 Reactive Power And Harmonics Control**

Reactive power requirements, Sources of Reactive Power, Smoothing reactor and DC Lines, Generation of Harmonics, Characteristic and Non-characteristic Harmonics, Troubles due to Harmonics, Harmonics Filters (AC Filters and DC Filters), Active Filters and Passive Filters (8)

**UNIT 5 Power Flow Analysis**

Interaction between AC and DC system, Power Flow in AC/DC Systems, DC system model, Basics of Multi-terminal DC (MTDC) system, Types of Multi-terminal DC (MTDC) system, Multi-In feed DC System (8)

**References:**


1. Padiyar K.R., "HVDC transmission system", Wiley Eastern Ltd., New Delhi, Second Edition, 2015.
2. Arrilaga J., "High voltage direct current transmission", Peter Pereginver Ltd. London, U.K., 1998.
3. Kim Bark E.W., "Direct current transmission – Vol.1", Wiley Inter Science, New York, 1971.

**EE437/EEE437 ELECTRICAL DISTRIBUTION SYSTEM & AUTOMATION**

(w.e.f. session: 2018-19)

**L T P C**
**3 1 0 4**

**Pre-requisites:** None **Co-requisites:** None

**UNIT-1 Industrial and commercial distribution system**

Energy Loss in distribution system, System ground for safety and- protection, Comparison of Overhead lines and underground cable system. (8)

**UNIT-2 Network model**

Power flow, Short circuit and calculations, Distribution system reliability analysis, Reliability concepts, Markov model, Distribution network reliability, Reliability performance (8)

**UNIT-3 Distribution system expansion planning**

Load characteristics, Load forecasting, Design concepts, Optimal location of sub-station, Design of radial lines, Solution technique (8)

**UNIT-4 System protection**

Requirement; Fuses and section analyzers; Over current, under voltage and under frequency protection; Co-ordination of protective device (8)

**UNIT-5 Introduction to Industrial Automation and Control**

Architecture of Industrial Automation Systems, Introduction to sensors and measurement systems, Temperature measurement, Pressure and Force measurements, Displacement and speed measurement, Flow measurement techniques, Measurement of level. (8)

**References:-**


1. Pabla. A.S., “Electrical Power Distribution, System”, Tata McGraw Hill, 1981.
2. Tuvar Goner, "Electrical Power Distribution System”, McGraw Hill, 1986.
3. Johnson C.D., "Process control instrumentation technology", Prentice-Hall, New Delhi, 2006
4. Kalsi H.S., “Electronic Instrumentation”, McGraw Hill, 3rd edition, New Delhi, 2010

**EE439/EEE439 HIGH POWER SEMICONDUCTOR DEVICES**

(w. e. f. Session 2018-19)

**L T P C**
**3 1 0 4**

**Pre-requisite:** Electronic Devices & Circuits, Analog Electronics, Power Electronics
**Co-requisite:** None

**Unit-1 Introduction**

Power Switching Waveforms, High Voltage Power Device Structures, Breakdown Model for Silicon, High Voltage Applications (8)

**Unit-2 SCR**

Operation & structure of Silicon Thyristors, Silicon Carbide Thyristors & Silicon GTO, Blocking characteristics (8)

**Unit-3 Power Bipolar Transistors**

Operation and structure of Silicon IGBT, SiC Planar MOSFET Structures and Silicon Carbide IGBT (8)

**Unit-4 Power MOS Devices**

Operation and structure of V MOS and DMOS, Heat Transfer in Power MOS devices, Device packaging (8)

**Unit-5 High Voltage Devices**

Operation and structure of Silicon MCT, Silicon BRT, Silicon EST, Gallium Nitride Devices (8)

**References:**


1. B. Jayant Baliga, "Fundamentals of Power Semiconductor Devices", 3rd edition, Springer, 2008
2. B. Jayant Baliga, "Advanced High Voltage Power Device Concepts", 1st edition, Springer, 2011
3. Robert Perret, "Power Electronics Semiconductor Devices", 1st edition, Wiley, 2009
4. Tadahiro Ohmi, Andre A. Jaecklin, "Power Semiconductor Devices & Circuits", 1st edition, Springer, 1992
5. Josef Lutz, Heinrich Schlangenotto, Uwe Scheuermann, Rik De Doncker, "Semiconductor Power Devices", Springer, 1st edition, 2011

**EE441/EEE441 FLEXIBLE AC TRANSMISSION SYSTEMS**
(w. e. f. Session 2018-19)

**L T P C**
**3 1 0 4**

**Pre requisites: None** **Co requisites:** None

**Unit-1 Introduction to FACTS**

Challenges and needs, Power Flow in AC transmission line, Power flow control, Description and definition of Flexible AC Transmission Systems (FACTS) controllers, Static power converter structures. (8)

**Unit-2 Power Semiconductor devices**

Types of power semiconductor devices, Voltage-sourced and Current-sourced converters, Converter output and harmonic control, Power converter control issues, Reactive power compensation. (8)

**Unit-3 Shunt Compensation**

Static VAR compensator (SVC), Static Synchronous Compensator (STATCOM), Thyristor-controlled Reactor (TCR) and Thyristor switched Reactor (TSR) Operation and control, Configurations and applications. (8)

**Unit-4**
**Series Compensation:** Thyristor Controlled Series Capacitor (TCSC), Static Synchronous Series Compensator (SSSC), Operation and control, Configurations and applications.
**Voltage and Phase angle regulators:** Thyristor controlled voltage regulators (TCVRs) and Thyristor controlled phase angle regulators (TCPARs) operation and control. (8)

**Unit-5 Shunt-Series compensation**
Unified power flow controller (UPFC), Power flow studies with FACTS controllers, Operational constraints, Interline Power flow Controller (IPFC), Operation and control. (8)

**References:**


1. Narain G. Hingorani, " Understanding FACTS", Wiley IEEE PRESS, Reprint 2015.
2. K.R. Padiyar, "FACTS Controllers in Transmission & Distribution", 3rd edition 2017.
3. V. K. Sood, "HVDC and FACTS Controllers: Applications of Static Converters in Power Systems", 2004.
4. Enrique Acha, C.R. Feurte, Esquivel, "Modelling and Simulation in Power Networks", Wiley-India edition, 2004.

**EE443/EEE443 SPECIAL ELECTRICAL MACHINES**

(w. e. f. Session 2018-19)

**L T P C**

**3 1 0 4**

**Pre-requisites: Electrical Machine** **Co-requisites: None**

**UNIT-I Poly-phase AC Machines**

Construction and performance of double cage and deep bar three phase induction motors, E.m.f. injection in rotor circuit of slip ring induction motor, Concept of constant torque and constant power controls, Static slip power recovery control schemes (constant torque and constant power). (8)

**UNIT-II**

**Single phase synchronous motor**: Construction, Operating principle and characteristics of reluctance and hysteresis motors.

**Two Phase AC Servomotors:** Construction, Torque-speed characteristics, Performance and applications. (8)

**UNIT-III**

**Stepper Motors:** Principle of operation; Variable reluctance, Permanent magnet and Hybrid stepper motors; Characteristics, drive circuits and applications.

**Switched Reluctance Motors:** Construction, Principle of operation, Torque production, Modes of operation, Drive circuits. (8)

**UNIT-IV Permanent Magnet Machines**

Types of permanent magnets and their magnetization characteristics, Demagnetizing effect, Permanent magnet dc motors, Sinusoidal PM ac motors, Brushless dc motors and their important features and applications, PCB motors, Introduction to permanent magnet generators. (8)

**UNIT-V Single Phase Commutator Motors**:

Construction, Principle of operation; Characteristics of universal and repulsion motors; Linear Induction Motors: Construction, Principle of operation, Linear force and applications. (8)

**Reference Books:**


1. P.S. Bimbhra "Generalized Theory of Electrical Machines", Khanna Publishers Limited, 5th Edition, 4th Reprint, New Delhi, 2000
2. P.C. Sen, "Principles of Electrical Machines and Power Electronics", John Wiley & Sons, 2nd edition, 2001.
3. G.K. Dubey, "Fundamentals of Electric Drives", Narosa Publishing House, 2nd edition, reprint 2017.
4. Cyril G. Veinott, "Fractional and Sub-fractional horse power electric motors", McGraw Hill International, 1986
5. M.G. Say, " Alternating current Machines", Pitman & Sons, 4th edition, 1976

**EE445/EEE445 ELECTRICAL SYSTEM & SUBSTATION DESIGN**

(w.e.f. session: 2018-19)

**L T P C**
**3 1 0 4**

**Pre-requisites:** None **Co-requisites:** None

**UNIT- I General Aspects**
National Electric Code (NEC) - scope and safety aspects applicable to low and medium (domestic) voltage installations, Electric services in buildings, Classification of voltages, Standards and specifications, IE Rules, IS Codes, General aspects of the design of electrical installations for domestic buildings – connected load calculation. (8)

**UNIT- II Distribution board**
Selection of main distribution board; Sub distribution board; MCCB, ELCB, MCB and cables for sub circuits; Pre-commissioning tests of domestic installations; Medium and HV installations – Selection of cables, Guidelines for cable installation & installation of induction motors. (8)

**UNIT- III Transformers**
Selection and installation of transformers, Switchgears and protective devices; Design of indoor and outdoor 11 KV substation up to 630 KVA: Design of Earthing system - Pipe, plate and mat earthing; Lightning arresters; Metering and protection; HT and LT breaker control panels; Selection of standby generator, installation and its protection. (8)

**UNIT- IV Illumination systems**
Design of illumination systems – Yard lighting, Street lighting and Flood lighting; Design and layout of installation for recreational or assembly buildings and high rise building; Design of Electrical system related to fire fighting, lifts and escalators. (8)

**UNIT-V Substation**
Types of Substation, Substation equipment and its function, Bus bar arrangement, Single busbar systems and duplicate bus-bar systems, Capacitor bank, Earthing practices, Substation automation (8)

**References:**


1. M.K.Giridharan, “Electrical System Design”. I.K. International Pvt. Ltd., 2011.
2. Raina & Bhattacharya, “Electrical Design Estimating and Costing”. New Age International, 1st Edition, 1991.
3. Bureau of Indian Standards publications, “National Electric Code”, 1986.
4. S.N. Singh, “Electric Power Generation, Transmission & Distribution”, PHI, 2015

**EE447/EEE447 ELECTRIC VEHICLES**

(w.e.f. session: 2018-19)

**L T P C**
**3 1 0 4**

**Pre-requisite**: Electro Mechanical energy Conversion EE**-211;** Power electronics **EE-303 Co-Requisites**: None

**UNIT-1 Introduction of Electric Vehicles**

Introduction, Types of electric vehicles, History of Electrical Vehicles (EV) , Configurations of Electric Vehicles, Relative merits and their limitations, Application, Environmental impact. (8)

**UNIT-2 Converters**

Introduction and working of semiconductor power diode, Thyristors and MOSFET, Power electronic DC-DC and DC-AC converters for electric and hybrid vehicles. (8)

**UNIT-3**

**Motors:** PMDC, Series motors, Induction Motors, Switched reluctance motor.
**Sensors:** Hall Effect sensors, optical encoders, current and speed sensing closed loop speed control of vehicle. (8)

**UNIT-4**

**Battery:** Basic, Type, Parameters, Capacity, Discharge Rate, State of Charge, Depth of Discharge, Characteristics, Properties of Batteries.
**Charge Controllers:** Purpose, Working and Limitations. (8)

**UNIT-5**

**Hybrid Electric Vehicles:** Types, Performance Parameters, Advantages and Disadvantages, Limitations.
**Electric Cars:** Emerging Trend, Hybrid Cars, Acceleration and Speed Characteristics,
**Fuel Cell Vehicles:** Fundamentals, Advance Hybrid Electric Vehicles. (8)

**References:**


1. Iqbal Hussain, "Electric & Hybrid Vehicles-Design Fundamentals", CRC press, 2nd Edition, 2011
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
3. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles Fundamentals", CRC Press, 2010.
4. Sandeep Dharmeja, " Electric Vehicle Battery System", Newnes, 2011
5. M.H. Rashid, "Power Electronics", Pearson, 3rd Edition, 2014

**EE449/EEE449 ENERGY CONSERVATION & ENERGY AUDIT**

(w.e.f. session 2018-19 )

**L T P C**
**3 1 0 4**

**Pre-requisites:** None **Co-requisites:** None

**Unit-1 Introduction**

Energy Scenario, Role of Energy Managers in Industries, Energy monitoring, Auditing & targeting, Economics of various Energy Conservation schemes, Total Energy Systems (8)

**Unit-2 Energy Audit**

Energy Audit, Types of energy audit, Identification of energy conservation opportunities, Various Energy Conservation Measures in Steam Losses in Boiler, Energy Conservation in Steam Systems – Case studies. (8)

**Unit-3 Energy conservation**

Classification of energy conservation measures, Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor energy consumption & energy saving potentials, Design consideration. (8)

**Unit-4 Refrigeration & Air conditioning**

Heat load estimation, Components of Heating ventilation and air conditioning (HVAC) system, Energy conservation opportunities in HVAC system-Case studies, Energy Efficiency in Lighting-Case studies. (8)

**Unit-5 Energy management & process**

Organizational background desired for energy management motivation; Detailed process of M&T; Thermostats; Boiler controls- proportional, differential and integral control; Optimizers; Compensators. (8)

**References:**


1. Eastop T.D. & Croft D.R., "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, ISBN-0-582-03184, 1990.
2. Reay D.A., "Industrial Energy Conservation", Pergamon Press, 1st edition, 1977
3. Kothari D. P., Nagrath I. J., "Power System Engineering", Tata McGraw-Hill Co., 2nd Ed., 2008
4. Singh S., Rathore U., "Energy Management", S. K. Kataria & sons, 2nd edition, 2017.