

# Integral University Lucknow

## Department of Electrical Engineering

### Study & Evaluation Scheme

#### B. Tech. (Electrical Engg.)

4 <sup>th</sup> YEAR		SEMESTER-VII								
S.No.	Course Code	Subject	Periods			Evaluation			Subject total	
			L	T	P	Sessional		End Sem. Exam.		
						CT	TA			Total
<b>THEORY</b>										
1.	IEE-701	Power System Protection	3	1	0	30	20	50	100	150
2.	IEE -702	Electrical Insulation in Power Apparatus & System	3	1	0	30	20	50	100	150
3.	IEE -703	Advance control system	3	1	0	30	20	50	100	150
4.	IEE -704	Energy Management systems & SCADA	2	1	0	15	10	25	75	100
5.		Elective -I	3	1	0	30	20	50	100	150
6.		Open Elective	3	1	0	30	20	50	100	150
<b>Practical/Training/Project</b>										
7.	IEE -751	Power system Protection Lab	-	-	03	10	10	20	30	50
8.	IEE -752	Project-I	-	-	03	-	-	50	-	50
9.	IEE -753	Power System Lab -II	-	-	03	10	10	20	30	50
10.	IEE -754	Summer Training Assessment	-	-		-	-	50	-	50
11.	GP-701	General Proficiency	-	-	-	-	-	50	-	50
<b>Total</b>			17	06	09	185	130	465	635	1100

**L-Lecture T-Tutorial P-Practical CT-Class Test TA-Teacher Assessment**

**Sessional Total** = Class Test + Teacher Assessment

**Subject Total** = Sessional total + End semester Examination

### LIST OF ELECTIVES & OPEN ELECTIVE

#### ELECTIVE-I

1. SPECIAL ELECTRICAL MACHINES
2. POWER QUALITY & MITIGATION
3. HIGH POWER SEMICONDUCTOR DEVICES

#### **SUBJECT CODE**

IEE-011  
IEE-012  
IEN-013

#### OPEN ELECTIVE (offered by Electrical Engg Deptt.)

#### **SUBJECT CODE**

1. RENEWABLE ENERGY & GRID INTEGRATION

OEEE-01

# IEE-701 POWER SYSTEM PROTECTION

w. e. f. Session 2015-16

**L T P**  
**3 1 0**

## Unit I:

**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 II:

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 III:

### **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 IV:

**Circuit Braking:** Arc phenomenon, properties of arc, arc extinction theories, recovery voltage and restriking 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, SF<sub>6</sub>, Vacuum Circuit Breakers, DC circuit breakers. (8)

## Unit V:

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)

## **Reference Books:**

1. S. S. Rao, "Switchgear and Protection", Khanna Publishers.
2. B. Ravindranath and M. Chander, Power system Protection and Switchgear, wiley Eastern Ltd.
3. B. Ram and D. N. Vishwakarma, "Power System Protection and Switchgear", Tata Mc. Graw Hill
4. Y. G. Paithankar and S R Bhide, "Fundamentals of Power System Protection", Prentice Hall of India.
5. T.S.M Rao, "Power System Protection: Static Relays with Microprocessor Applications" Tata Macgraw Hill".
6. A.R. Van C. Warrington , " Protective Relays- Their Theory and Practice, Vol. I & II" Jhon Willey & Sons.

# IEE-702 ELECTRICAL INSULATION IN POWER APPARATUS AND SYSTEM

w. e. f. Session 2015-16

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## Unit I:

### **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, electromechanical breakdown, breakdown of solid, dielectric in practice, breakdown in composite dielectrics. (8)

## Unit II:

Generation of High Voltage and Currents

Generation of High direct Current Voltage, Generation of high voltage alternating voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators. (8)

## Unit III:

### **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 IV:

### **Over Voltage Phenomenon & insulation Coordination:**

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

## Unit V:

### **Non -Destructive Testing**

Measurement of direct current resistively, measurement of dielectric constant and loss factor, partial discharge measurements.

Non destructive insulation test techniques:

- a. Dynamic properties of dielectrics
- b. Dielectric loss and capacitance measurement
- c. Partial discharge measurements. (8)

### **Reference books:**

1. E Kuffel and W.S.Zacngal , High voltage Engineering: Pergamum Press
2. M.S.Naidu & V. Kamaraju,"High Voltage Engineering," Tata Mcgarw hill
3. C.L. Wadhwa,"High Voltage Engineering", Wiley Eastern Ltd.
4. M.Khalifa," High Voltage Engineering theory and practice, "Marcel Dekker.
5. Subir Ray." An Introduction to High Voltage Engineering" Prentice Hall of India.

# IEE-703 ADVANCE CONTROL SYSTEM

(w. e. f. Session 2015-16)

**L T P**  
**3 1 0**

## Unit-I

### **State Space Analysis of Continuous System:**

Review of state variable representation of continuous system, State variable description conversion of state variable models to transfer function and vice-versa, solution of state equations, Concept of controllability and observability of continuous system. (8)

## Unit-II

### **Analysis of Discrete System:**

Discrete system, state variable model and transfer function model of discrete system, conversion of state variable model to transfer function model and vice-versa, modeling of sample-hold circuit, solution of state difference equations, Concept of controllability and observability of discrete system (8)

## UNIT-III

### **Stability Analysis of Discrete Systems:**

Principles of Discretization-Bilinear transformation, stability on Z-plane, BIBO stability, Zero-Input stability, Jury stability criterion

### **Pole-Placement Design and State observer:**

Concept of pole-placement, Stability improvement by state Feedback, State regulator design, design of state observers and controller. (8)

## Unit-IV

### **Non linear Control System:**

Types and characteristics of non linearity, phenomena related to non-linear systems.

Phase plane analysis, types of phase portraits, singular points, construction of phase portraits, system analysis by phase-plane method, describing function and its application to system analysis. (8)

## Unit-V

### **Lyapunov's Stability analysis:**

Concept of Lyapunov's stability, Stability of equilibrium state, asymptotic stability, Lyapunov's stability theorems for continuous and discrete systems, methods of generating Lyapunov's function for continuous and discrete system, Stability analysis of non linear system, construction of Lyapunov functions using krasovskii method, variable gradient method. (8)

## References

1. M.Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill
2. Ajit K.Madal, "Introduction to Control Engineering: Modelling, Analysis and Design"
3. New Age International.
4. D.Landau, "Adaptive Control", Marcel Dekker Inc.
5. S.Rajasekaran & G.A.Vjayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic
6. Algorithms: Synthesis and Applications" Prentice Hall of India.

**IEE-704: Energy Management Systems and SCADA**  
(w. e. f. Session 2015-16)

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**Unit-I:**

Energy Scenario, Energy Resources, Energy Sector Reforms & Restructuring, Energy Security, Energy Conservation Act and its features, Energy Conservation, Energy Audit, Energy Bench Marking, Maximizing System Efficiencies, Energy Audit Instruments, Duties and Responsibilities of Energy Managers and Auditors , Energy audit in Generation, Transmission & Distribution system. (8)

**Unit-II:**

Energy Economics, Energy Management Centres and Their Functions, Architectures, recent Developments. Characteristics of Power Generating Units and Economic Dispatch. Unit Commitment (Spinning Reserve, Thermal, Hydro and Fuel Constraints); Solution techniques of Unit Commitment. Generation Scheduling with Limited Energy. (8)

**Unit-III:**

Energy Production Cost – Cost Models, Budgeting and Planning, Practical Considerations. Interchange Evaluation for Regional Operations, Types of Interchanges. Life cycle Coasting Exchange Costing Techniques. Comparative Economic evaluation of alternatives. Deregulation in power sector. (8)

**Unit-IV:**

Introduction to Supervisory Control and Data Acquisition. SCADA Functional requirements and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, RTU (Remote Terminal Units) Connections. SCADA in Power System Automation. SCADA Communication requirements. Human Machine interface. (8)

**References:**

1. M. H. J. Bollen, "*Understanding Power Quality Problems Voltage sags and Interruptions*".
2. Handschin, E. "*Energy Management Systems*", Springer Verlag, 1990.
3. John D Mc Donald, "*Electric Power Substation Engineering*", CRC press, 2001.
4. Wood, A. J and Wollenberg, B. F, "*Power Generation Operation and Control*", 2<sup>nd</sup> Edition John Wiley and Sons, 2003.
5. Green, J. N, Wilson, R, "*Control and Automation of Electric Power Distribution Systems*", Taylor and Francis, 2007.
6. Turner, W. C, "*Energy Management Handbook*", 5<sup>th</sup> Edition, 2004.

## IEN-013 HIGH POWER SEMICONDUCTOR DEVICE

w. e. f. Session 2015-16

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3 1 0

### Unit-I

**Basic Device Model:** Theory of bipolar and MOS transistors, small signal models of bipolar MOS transistor, Gummel –Poon model. (7)

### Unit-II

**High Current Effects in Diodes :**Dependence of lifetime on high level injection, non uniform current distribution under high current injection. (7)

### Unit-II

**Power Bipolar Transistors:** Onset of high current effects in transistors, theory of kirk effect,crowding, pinch-in effects, second breakdown, etc, Emitter geometries for high current and HF operation. (8)

### Unit-IV

**SCR:** Theories of operation, relation between shorted emitted and  $dv/dt$  rating, gate turn off devices, inverter, grade SCRs, special diffusion technique for SCRs. (8)

### Unit-V

**Heat Transfer in Power Devices:** Power MOS devices, V MOS & DMOS device structure and models, device packaging. (8)

### **Reference Book:**

1. S.M Sze, Physics of semiconductor devices, 2<sup>nd</sup> ed. Wiley, 1981

# IEE-012: Power Quality & Mitigation

w. e. f. Session 2015-16

**L T P**  
**3 1 0**

## Unit I:

Definitions of various powers, power factor and other figures of merit under balanced, unbalanced and non-sinusoidal conditions. Power Quality issues, Genesis of power quality problem, effects on power system, remedies, harmonics and their mitigation, Power Quality Standards. (8)

## Unit-II:

Power quality characterisation & analysis- Load, Power factor, Harmonic distortion indices, Transient, unbalancing & symmetrical component, Voltage Sag, Swell, flicker, Harmonic Distortion limit. (4)

Introduction to custom power devices and their applications in power system. (3)

## Unit-III:

Source Side compensation, Theories of load compensation, Load Balancing, Capacitor bank. (9)

## Unit-IV:

Active, Passive & Hybrid filter, Shunt, Series & combination of shunt- series filter. Reference Current generation, P-Q theory. (8)

## Unit-V:

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 Baghini, John Wiley & Sons, "*Handbook of power quality*", 2008.
4. GJ Walkilen, "*Power system harmonics*".
5. Roger C. Dugan, "*Electrical power systems quality*", Tata McGraw-Hill, 2002.
6. H. Akagi, "*Instantaneous power theory and application to power conditioning*", IEEE Press, 2007.
7. "*IEEE 519 Standards*"

# IEE-011: SPECIAL ELECTRICAL MACHINES

(w. e. f. Session 2015-16)

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**3 1 0**

## 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.
- 2.P.C. Sen "Principles of Electrical Machines and Power Electronics" John Willey & Sons, 2001
- 3.G.K.Dubey "Fundamentals of Electric Drives" Narosa Publishing House, 2001
- 4.Cyril G. Veinott "Fractional and Sub-fractional horse power electric motors" McGraw Hill International, 1987
5. M.G. Say "Alternating current Machines" Pitman & Sons

# OEEE-01 Renewable Energy & Grid Integration

w. e. f. Session 2015-16

**L T P**  
**3 1 0**

## **Unit I:**

**Introduction:** Fossil fuel based systems, Impact of fossil fuel based systems, Classification of Energy Resources, Renewable Energy- Sources & Features, Seasonal variation & availability, Advantages & Disadvantages, Hybrid Energy Systems, Distributed Energy system & Dispersed generation (DG), World Energy Status, Energy Scenario in India, Introduction to Grid, Advantages, Grid concept in Indian prospects.(6)

## **Unit II:**

**Solar Energy Basics:** The Sun as a source of energy, Terrestrial & Extraterrestrial radiations, Spectral Energy Distribution, Solar radiation data & geometry. (2)

Solar Photovoltaic Systems- Solar Cell- Fundamentals, Characteristics. Solar Cell, Module, Array and Panel, Maximum power point tracking, load matching. Solar thermal system- Solar collectors & solar water heater. Solar thermo-mechanical system- solar pond electric power plant, solar thermal electric power plant. Solar PV systems- roof-top and domestic PV systems, Standalone PV system, Grid connected PV system. (7)

## **Unit III:**

**Wind Energy-** Wind Patterns, Wind data and Site selection, Wind turbine- Aerodynamics, Characteristics & types, Wind Energy conversion system, Various Electrical generators, Standalone and grid interface of WECS Microhydel- Operating principle, Components of Microhydel power plant, Types & Characteristics of turbine, Load Balancing & Grid interface. (8)

## **Unit IV:**

**Emerging Technology-** Fuel cells, classification and characteristics, power electronics interfaces, Fuel Cell Power Plant, Hydrogen Energy, Ocean Thermal Energy Conversion Technology, Their environmental aspects & Present Status in India. (5)

Large energy storage technologies (MW) -Magneto-Hydrodynamic Power Conversion & their grid interface, Nuclear Energy- Types, Characteristics, Nuclear power plant & their environmental aspects. (4)

## **Unit V:**

**Hybrid Systems-** Need & Types of Hybrid system, Diesel-PV, Wind-PV, Microhydel-PV, electric and hybrid electric vehicles. (4)

Grid Integration-Integration of renewable energy systems, Components required for grid integration, Grid integration issues and standards, tariff related to renewable energy interface, Concept of Smart Grid. (4)

## **Reference Books:**

1. B. H. Khan, '*Non-conventional Energy Resources*', Tata McGraw-Hill
2. M. R. Patel, '*Wind and Solar Power Systems*', Tailor & Francis CRC Press, USA, 2006.
3. M. H. Rashid, '*Power Electronics Handbook*', Academic Press, Florida, 2001.
4. Bin Wu, Yongqiang Lang, NavidZargari, '*Power Conversion and Control of Wind Energy Systems*', WILEY 2011.
5. Fesis, L.L. '*Wind and Solar Power Systems*', CRC Press.