INTEGRAL UNIVERSITY, LUCKNOW
Department of Electrical Engineering

M. Tech. Power System Engineering
Study & Evaluation Scheme
(w. e. f. 2018-19)

Semester-III, Year II

S.No	Subject Code	Category	Subject Name	Periods				Evaluation Scheme				Total
								Sessional			Exam	
				L	T	P	C	CT	TA	Total	ESE	
1.	EE-611	DC	FACTS Devices & HVDC Transmission	4	0	0	4	25	15	40	60	100
2.	EE-612	DC	Power System Optimization	4	0	0	4	25	15	40	60	100
3.		DE	Departmental Elective –II	4	0	0	4	25	15	40	60	100
4.		DE	Departmental Elective –III	3	0	0	3	25	15	40	60	100
5.	EE-632	DC	Colloquium	0	0	2	1	-	100	100	-	100
6.	EE-699	DC	M.Tech. Dissertation	-	-	-	4	-	60	60	40	100
			Total	**15**	**0**	**2**	**20**	**100**	**220**	**320**	**280**	**600**

Semester-IV, Year II

S.No	Subject Code	Category	Subject Name	Periods				Evaluation Scheme				Total
								Sessional			Exam	
				L	T	P	C	CT	TA	Total	ESE	
1.	EE-699	DC	M.Tech. Dissertation	-	-	-	4		60	60	40	100
2.	EE-699	DC	M.Tech. Dissertation	-	-	-	4		60	60	40	100
3.	EE-699	DC	M.Tech. Dissertation	-	-	-	4		60	60	40	100
4.	EE-699	DC	M.Tech. Dissertation	-	-	-	4		60	60	40	100
			Total	**0**	**0**	**0**	**16**		**240**	**240**	**160**	**400**
										Grand Total		**2000**

Total Credits: 72

L-Lecture **T-T**utorial **P-**Practical **C**-Credit **CT-**Class Test
TA-Teacher Assessment **Sessional Total** = Class Test + Teacher Assessment
Subject Total = Sessional Total + End Semester Examination

INTEGRAL UNIVERSITY, LUCKNOW
Department of Electrical Engineering
M. Tech. Power System Engineering

Departmental Elective I

High Voltage Testing Techniques	EE 521
Power System Stability	EE 522
Advance Electric Drives	EE 523

Departmental Elective II

Power Quality Assessment	EE-613
Power System Restructuring & Deregulation	EE-614
Soft Computing in Solar PV and Wind Energy Conversion Systems	EE-621

Departmental Elective III

SCADA Systems and Applications	EE-616
Power System Transients	EE-617
Maintenance and Testing of Electrical Power Apparatus	EE-618

EE-611/EEE-611 FACTS DEVICES & HVDC TRANSMISSION
(w. e. f. session 2018-19)

L T P C
4 0 0 4

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

UNIT-1 FACTS concepts and General system considerations

Introduction to power semiconductor devices: Diode, GTO, MOSFET, IGBT, MOS Controlled Thyristor**;** Transmission interconnection; Power flow in ac system; Power flow and dynamic stability considerations; Basic of FACTS controllers: Shunt, Series, Combined and other controllers; FACTS technology; HVDC or FACTS**.** (8)

UNIT-2 Voltage Source Converters

Basic concepts, Single phase full wave bridge converter operation, Three phase full wave bridge converter, Sequence of valve conduction process in each phase leg, Transformer connections for 12 pulse operation, Three level voltage sourced converter, PWM converter. (8)

UNIT-3 Self and Line Commutated Current Sourced Converters

Basic concepts, Three phase full wave diode rectifier, Thyristor based converter, Rectifier and inverter operation valve voltage and commutation failure, Current sourced versus voltage sourced converters (8)

UNIT-4 FACTS Devices

Introduction, Objectives of shunt compensation, Methods of controllable VAR Generation, Static VAR Compensators, SVC and STATCOM, Static series compensators, TSSC, TCSC and SSC. (8)

UNIT-5 Combined Compensators

Introduction, Unified power flow controller (UPFC), Conventional power control capabilities, Real and reactive power flow control, Comparison of UPFC to series compensators, Control structure, Dynamic performance, Interline power flow controller basic operating principles, Control structure, Application considerations. (8)

References:

1. N.G. Hingorani and L. Ayugyi, "Understanding FACTS concepts and Technology of Flexible AC Transmission system", Standard Publication, New Delhi, 2001.
2. K.R. Padiar, "HVDC power transmission", New Age International, 1990.
3. J. Arrillaga, "High voltage direct current Transmission", IET digital library, 2nd Edition, 1998.
4. E.W. Kimbark, "Direct Current transmission", Wiley-Blackwell, 1st Edition, 1971.

EE-612/EEE-612 POWER SYSTEM OPTIMIZATION
(w. e. f. session 2017-18)

L T P C
4 0 0 4

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

Unit-1

Fundamentals of optimization techniques: Definition, Classification of optimization problems, Unconstrained and Constrained optimization, Optimality conditions, Classical Optimization techniques (Lamda Iteration method, Linear programming, Quadratic programming).

Lamda iteration method: Brief introduction to Lamda iteration method, Formulation of the Lagrange function, Lamda iteration method to solve optimal dispatch problem. (8)

Unit-2 Quadratic programming

Introduction to quadratic programming, Working principle, Sequential programming, Linear constrained optimization problem, Karush-Kuhn-Tucker conditions and its application to solve various problems, Interior point method, Lagrangian duality. (8)

Unit-3 Linear programming

Examples of linear programming problem, The Simplex Method I, Fundamental theorem of linear programming, Weak and strong duality theorems, Integer programming, Network flow, Development of a linear programming model from problem description. (8)

Unit-4 Particle Swarm Optimization

Fundamental principle; Velocity Updating; Advanced operators; Parameter selection; Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) - Binary, Discrete and combinatorial (8)

Unit-5 Application of population based optimization techniques in power systems

Algorithms and flow chart of various optimization techniques for solving economic load dispatch and hydro-thermal scheduling problem. (8)

References:

1. S. S. Rao, "Engineering Optimization", New Age International (P) Ltd, 3rd Edition, 2013.
2. S.N.Sivanandam & S.N. Deepa, "Principle of soft computing", 2nd Edition, 2011.
3. Jizhong Zhu, "Optimization on Power system Operation", Wiley-IEEE Press, 2nd Edition 2015.
4. K.P. Chong, Stanislaw H. Zak, "An Introduction to Optimization", Wiley online library, 3rd Edition, 2011.

EE-613/EEE- 613 POWER QUALITY ASSESSMENT
(w. e. f. Session 2018-19)

L T P C
4 0 0 4

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

Unit-1 Introduction to Power Quality

Importance of power quality; Terms and definitions of power quality as per IEEE std. 1159 such as transients, Short and long duration voltage variations, Interruptions, Short and long voltage fluctuations, Imbalance, Flickers and transients; Symptoms of poor power quality. (8)

Unit-2 Power Quality issues

Genesis of power quality problem, Effects on power system, Remedies, Power Quality Standards, Power quality characterization & analysis - Unbalance, Voltage Sag, Swell, Flicker. (8)

Unit-3 Power system harmonics

Harmonics, Inter-harmonics, Sub-harmonics, Difference between harmonics and transients, Voltage and current distortion, Harmonic indexes, Sources of harmonic distortion, Effects of harmonic distortion, Mitigation and control techniques, Harmonic filters. (8)

Unit-4 Load compensation

Theories of load compensation; Load Balancing; Capacitor bank; Active, Passive & Hybrid filter; Shunt, Series & combination of shunt- series filter; P-Q theory (8)

Unit-5 Power quality conditioners

Shunt and series compensators, DSTATCOM, Dynamic voltage restorer, Unified power quality conditioners. (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, 2002.
5. H. Akagi, "Instantaneous power theory and application to power conditioning", IEEE Press, 2007.
6. "IEEE 519 Standards".

EE-614/EEE-614 POWER SYSTEM RESTRUCTURING & DEREGULATION
(w. e. f. Session 2018-19)

L T P C
4 0 0 4

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

UNIT-1

Introduction: Basic concept and definitions, Privatization, Restructuring, Transmission open access, Wheeling, Deregulation, Components of deregulated system, Advantages of competitive system

Power System Restructuring: An overview of the restructured power system, Difference between integrated power system and restructured power system, Explanation with suitable practical examples (8)

UNIT-2 Deregulation of Power Sector

Separation of ownership and operation, Deregulated models, Pool model, Pool and bilateral trade model, Multi-lateral trade model (8)

UNIT-3 Competitive electricity market

Independent System Operator (ISO) activities in pool market, Wholesale electricity market characteristics, Central auction, Single auction power pool, Double auction power pool, Market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services, Transmission Pricing. (8)

UNIT-4

Open Access Same Time Information System (OASIS): Introduction, Structure, Functionality, Implementation, Posting of information, Uses

Congestion Management: Congestion management in normal operation, Explanation with suitable example, Total transfer capability (TTC), Available transfer capability (ATC), Transmission Reliability Margin (TRM), Capacity Benefit Margin (CBM), Existing Transmission Commitments (ETC) (8)

UNIT-5 Experiences in deregulation

U.S.A, Canada, U.K, Japan, Switzerland, Australia and Indian power system (8)

References:

1. Loi Lei Lai, “Power System Restructuring and Deregulation”, John Wiley & Sons Ltd., 2001.
2. Lorrin Philipson and H. Lee Willis, “Understanding Electric Utilities and Deregulation”, Marcel Dekker Inc., New York, CRC Press, 2005.
3. Marija llic, Francisco Galiana and Lestor Fink, “Power System Restructuring Engineering & Economics”, Kulwer Academic Publisher, USA, 2000.

EE-616/EEE-616 SCADA SYSTEMS AND APPLICATIONS
(w. e. f. Session 2018-19)

L T P C
3 0 0 3

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

Unit-1 Introduction
Data acquisition system, Evaluation of SCADA (Supervisory control and data acquisition system), Objectives, Benefits and functions of SCADA, Monitoring and control using SCADA, SCADA applications (8)

Unit-2 SCADA system components
Schemes, Remote terminal unit, Intelligent electronic devices, Communication Interface, Master station, SCADA Architecture, Single unified standard architecture, HMI (Human machine interface system) (8)

Unit-3 SCADA Communication
Polled (Master – Slave), Contention (Peer to Peer), Basic standards (RS 232 and RS 485), Open system interconnection model (8)

Unit-4 SCADA Applications
Automation of Electrical Distribution system, Substation control using SCADA, Feeder control using SCADA, End User load control automation by SCADA, Advantages of implementing SCADA system for electrical Distribution (8)

References:

1. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 4th edition, 2009.
2. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.
3. William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.
4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
5. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", Penn Well, 1999.

EE-617/EEE-617 POWER SYSTEM TRANSIENTS
(w. e. f. session 2018-19)

L T P C
4 0 0 4

Pre-requisite: Advance Power System Analysis (EE-515) **Co-requisite:** None

Unit-1 Simple Switching Transients
Origin and nature of transients and surges, Circuit closing transients, Recovery transient initiated by the removal of a short circuit, Double-frequency transients (8)

Unit-2 Abnormal Switching Transients
Normal & Abnormal switching transients, Current suppression, Capacitance switching, Re-striking phenomena, Transformer magnetizing inrush current (8)

Unit-3 Transients in Three-Phase Circuits
Introduction, Importance of the type of Neutral connection, Switching a 3-Φ reactor with an isolated neutral, 3-Φ Capacitance switching (8)

Unit-4 Travelling Waves & other Transients on Transmission Lines
Attenuation & Distortion of travelling waves, Switching operations involving transmission lines, Multiconductor systems and multivelocity waves, Switching surges on an integrated system (8)

Unit-5 Lightning
Scope of lightning problem, Physical phenomenon of lightning, Interaction between lightning & the power system, Induced lightning surges (8)

References:

1. Allan Greenwood, "Electrical Transients in Power System", Wiley, 2nd Edition, 2010.
2. C.S. Indulkar, D.P. Kothari, K. Ramalingam, "Power System Transients: A Statistical Approach", Prentice Hall India, 2nd Edition, 2010.
3. Akihiro Ametani, Naoto Nagaoka, Yoshihiro Baba, Teruo Ohno, "Power System Transients: Theory and Applications", CRC Press, 1st Edition, 2013
4. Pritindra Chowdhuri, "Electromagnetic Transients in Power Systems", Prentice Hall India, 2nd Edition, 2008.
5. Badri Ram, D.N. Vishwakarma, "Power System Protection & Switchgear", McGraw Hill Education, 2nd Edition, 2017.

EEE-618 MAINTENANCE AND TESTING OF ELECTRICAL POWER APPARATUS
(W.e.f. Session: 2018-19)

L T P C
3 1 0 4

Pre-requisite: EMEC and Electrical Measurement and Instrumentation **Co-Requisites**: None

UNIT-1 Maintenance and Testing Strategies
Introduction, Need for Maintenance and Testing, Overview of Electrical Maintenance and Testing Strategies, Planning an Electrical Preventive Maintenance Program, Overview of Testing and Test Methods (8)

UNIT-2 Maintenance and Testing of Transformers
Preventive Maintenance of Transformers, Transformer Installation, Acceptance and Maintenance, Dry-Type Transformers, Liquid-Type Transformer, Transformer Testing. (8)

UNIT-3 Maintenance and Testing of Motors, Generators and Cables
Motor and Generator Maintenance, Testing of Motors and Generators, Maintenance of Cables, Field Testing of Medium-Voltage Cables (8)

Unit 4 Maintenance and Testing of Switchgear
Medium-Voltage Electrical Switchgear Maintenance and Care, Medium-Voltage Electrical Switchgear Testing, Low-Voltage Switchgear Maintenance and Care, Maintenance and Testing of Low-Voltage Protective Devices (8)

Unit 5 Maintenance and Testing of Instrument Transformers and Protective Relays Testing for Polarity of Instrument Transformers, Testing for Ratio of Instrument Transformers, Maintenance and Testing of Instrument Transformers, Testing and Maintenance of Electromechanical Protective Relays, Testing and Commissioning of Static and Digital Relays
(8)

References:

1. Paul Gill, "Electrical Power Equipment Maintenance and Testing", Second Edition, CRC press, 2011
2. M.V. Deshpande, "Design and Testing of Electrical Machines", PHI Learning Press, 2013.
3. N.H. Malik, A.A. Al-Arainy, M.I. Qureshi, "Electrical insulation in power system", Marcell &Dekker Inc., 1998.

EE 621/EEE 621 SOFT COMPUTING IN SOLAR PV AND WIND ENERGY CONVERSION SYSTEMS
(w. e. f. Session 2018-19)

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UNIT-1 Solar PV Energy Conversion Systems

Basics of Solar PV; PV Module Performance Measurements; Balance of System and Applicable Standards; Types of PV Systems: Grid-Connected Solar PV System, Stand-Alone Solar PV System, PV-Hybrid Systems, Stand-Alone Hybrid AC Solar Power System with Generator and Battery Backup; Charge Controller; Batteries in PV Systems; Maximum Power Point Tracking Techniques. (8)

UNIT-2 Soft Computing Techniques in Solar PV

MPPT Using Fuzzy Logic controller (FLC), Description and Design of FLC, Neural Networks for MPP Tracking, Algorithm for ANN Based MPPT, Neuro-Fuzzy Based MPPT Method, Fuzzy Neural Network Hybrids, Theoretical Background of ANFIS, Architecture of Adaptive Neuro-Fuzzy Inference System, Hybrid Learning Algorithm. (8)

UNIT-3 Wind Energy Conversion Systems

Wind Characteristics; Wind Turbine; Fixed-Speed Wind Turbines; Variable-Speed Wind Turbines; Components of WECS; Types of Wind Turbine Generators; Power Converter Topologies for Wind Turbine Generators: Permanent Magnet Synchronous Generators, Doubly Fed Induction Generators; Grid Connection. (8)

UNIT-4 Soft Computing Techniques in Wind Energy Conversion Systems

Prediction of Wind Turbine Power Factor, Problem Formulation, Artificial Neural Networks, Adaptive Neuro-fuzzy Inference System (ANFIS), Description of Profile Types, Design of the ANN, ANFIS for Prediction of Power Factor, Estimation of the Optimal Power Factor, Pitch Angle Control, Fuzzy Logic Controllers, Genetic Algorithms, Genetic Algorithm Controller for Pitch Angle Control, Fuzzy Logic Based MPPT Controller. (8)

UNIT-5 Hybrid Energy Systems

Need for Hybrid Energy System, Architecture of Solar-Wind Hybrid System, Small Domestic Power Grid Based on Hybrid Electrical Power, Small Industrial Power System Based on Hybrid Renewable Energy, Fuzzy Logic Controller for Hybrid Power System, Design Considerations, Intelligent Controller. (8)

References:

1. S. Sumathi, L. Ashok Kumar, P. Surekha, "Solar PV and Wind Energy Conversion Systems", Springer International Publishing, Switzerland, 2015.
2. Ashok Desai V., "Non-Conventional Energy", Wiley Eastern Ltd., 1990.
3. Mittal K.M., "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd., 1997.
4. Ramesh R., Kurnar K.U., "Renewable Energy Technologies", Narosa Publishing House, New Delhi, 1997
5. B. H. Khan, "Non-Conventional Energy Resources", TMH Education Private Ltd., New Delhi, 2009.