## Scheme of Examination

Second Semester –M.Tech. (Electrical Power System)

| S.No. | Subject Code | Subject Name | Periods /week | | | Total Credits | Maximum Marks Allotted | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Theory Slot | | | Practical Slot | | |
| | | | L | T | P | | End Sem. Exam. | Tests (Two) | Assignments /Quiz | End Sem. Practical / Viva | Practical Record/ assignment/ Quiz/Presentation | |
| 1. | MEPS-201 | Flexible AC Transmission Systems (Facts) | 3 | 1 | - | 4 | 70 | 20 | 10 | - | - | 100 |
| 2. | MEPS-202 | Energy Conservation , Management and Auditing | 3 | 1 | - | 4 | 70 | 20 | 10 | - | - | 100 |
| 3. | MEPS-203 | Power Quality and Monitoring | 3 | 1 | - | 4 | 70 | 20 | 10 | - | - | 100 |
| 4. | MEPS-204 | Transient Over Voltages In Power Systems | 3 | 1 | - | 4 | 70 | 20 | 10 | - | - | 100 |
| 5. | MEPS-205 | Power System Dynamics and Security | 3 | 1 | - | 4 | 70 | 20 | 10 | - | - | 100 |
| 6. | MEPS-206 | Lab -1:Advance Power System Lab | - | - | 6 | 6 | - | - | - | 90 | 60 | 150 |
| 7. | MEPS-207 | Lab -2 :Power Electronics Application to Power System Lab(Software Based) | - | - | 6 | 6 | - | - | - | 90 | 60 | 150 |
| | | Total | 15 | 5 | 12 | 32 | 350 | 100 | 50 | 180 | 120 | 800 |

L: Lecture- T: Tutorial- P: Practical

# Syllabus

## M .Tech II Semester (Electrical Power System)

## MEPS 201 Flexible AC Transmission Systems (FACTS)

**Unit-1: Introduction**: Facts basic concepts and general system considerations, power flow in ac system, definitions on facts, basic types of facts controllers, benefits from facts Technology, static var compensator (SVC): principle of operation and control strategy, Thyristor controlled phase angle regulator (TCPAR): principle of operation and control strategy.

**Unit-2: Transient Stability Analysis**: Analysis of Power systems installed with FACTS devices.
**Control with FACTS:** Power Transmission Control using UPFC, Power Transmission Control using Phase Shifting Transformer (PST), Power Transmission Control using SSSC.

**Unit-3**: **Oscillation Stability Analysis and Control with FACTS**: Linearised model of power systems installed with FACTS based Stabilizers, Heffron-Phillips model of a SMIB system installed with SVC, TCSC and TCPS, Heffron-Phillips model of a SMIB system with UPFC, Heffron-Phillips model of a Multi-machine system installed with SVC, TCSC and TCPS.

**Unit-4**: **Design of FACTS based stabilizers**: Analysis of damping torque contribution by FACTS based stabilizers installed in SMIB systems, Selection of installing locations and feedback signal for FACTS based stabilizers, Dynamic Voltage restorer.

**Unit-5: Power flow Controller:** Unified Power Flow Controller (UPFC): Principle of operation, configuration and control, Simulation of UPFC, Steady state model of UPFC, Interline Power Flow Controller (IPFC): Principle of operation, configuration and control, Static compensator (STATCOM): principle of operation and control, Application for mitigation of ssr.

**References:**

1. "Understanding FACTS Devices" N.G. Hingorani and L. Guygi. IEEE Press Publications 2000.
2. Flexible AC Transmission System: Y.H.Song and A.T.Jhons, IEE, 1996(A Book)
3. Dr Ashok S & K S Suresh Kumar "FACTS Controllers and applications" course book for STTP, 2003.
4. Ned Mohan et.al, Power Electronics, John Wiley and Sons.
5. K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International, First Edition.

# MEPS 202 Energy Conservation, Management and Auditing

**Unit-1: Energy auditing:** Concepts of Energy audit, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy audit of industries- process industry, thermal power station, building energy audit, Thermal energy audit in heating, ventilation and air conditioning, Energy monitoring, Energy accounting and analysis, targeting, Loss of energy in material flow, Maximizing system efficiency, Energy auditing instruments.

**Unit-2:Energy Conservation**- Thermodynamics of Energy Conservation, Basic principle, Irreversibility and second law, Energy storage for power systems (Mechanical, Thermal, Electrical & Magnetic) Energy conservation task before industry, Energy conservation equipments, Co-Generation, Energy conservation in Sugar, Textiles, Cement, process industry, Electrical Energy Conservation in building, heating, lighting, domestic gadgets, Energy Conservation in transportation system especially in electric vehicle, Primary energy sources, optimum use of prime-movers, energy efficient housekeeping, energy recovery in thermal systems, waste heat recovery techniques.

**Unit3-:Energy Management**- Principles of energy management, energy management program, initiating, planning, controlling, promoting, monitoring, reporting, Energy manager, qualities and function of energy managers, Language of an energy manager.

**Unit-4: Economic Analysis** -Economics Analysis-Depreciation Methods, time value of money, rate of return , return on investment ,replacement analysis, life cycle costing analysis- calculation of simple payback method, Payback period, net present worth method, , lighting ,Applications of life cycle costing analysis, Load curve analysis, load management DSM, Restructuring of electric tariff from energy conservation consideration, Energy economics, Cost Benefit Risk analysis.

**Unit-5: Energy Efficient Motor, Instrument &Pf Improvement:**

Power factor improvement methods, location of capacitors, Pf with non linear loads, effect of harmonics on power factor, power factor motor controllers

Energy instruments- wattmeter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's.

Energy efficient motors-Energy efficient electric drives, factors affecting efficiency, loss distribution.

**References:**

1. Energy management by W.R. Murphy AND G. Mckay Butter worth, Heinemann publications.
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
3. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition,1995
4. Energy management hand book by W.C.Turner, John wiley and sons
5. Energy management and good lighting practice: fuel efficiency- booklet12-EEO
6. Elect, Energy Utilization & Conservation. Dr. Tripathi S.C.,
**7.** Energy Management – W.R. Murphy & G. Mckey Butler worths.
8. Energy Management Head Book- W.C. Turner, John Wiley
9. Energy conservation & Management: JB GUPTA

# MEPS 203 Power Quality and monitoring

**Unit-1: Introduction:** Power quality basics, types of power quality disturbances, power quality indices, Causes and effects of power quality disturbances , Voltage, Sag, Swell, Surges, over voltages, spikes, Voltage fluctuations, , Interruption, Remedies to improve power quality.

**Unit -2: Transients:** Origin and classifications, capacitor switching transient, lightning-load switching , impact on users ,protection, mitigation, causes and effects of harmonics, converter configuration and their contribution to supply harmonics, other sources of harmonics.

**Unit -3**:**Controlling**:Active wave shaping of input line current, constant frequency control, constant tolerance band control, variable tolerance band control, discontinuous current control, Electromagnetic interference(EMI), EMI generation ,EMI standards, and elimination.

**Unit- 4**: **Filters** :Radio interference, supply standards, suppression of harmonics, passive input filters, design of harmonic filters, Improved power quality converter topologies,(single and three phase), transformer connections, reduction of harmonics using active power filters – topologies, and their control methods, PWM converter as a voltage source active filter, current source active filter.

**Unit- 5**: **Power Quality conditioners**: Shunt and series compensators, DStatcom-Dynamic voltage restorer, unified power quality conditioners, case studies.

**References:**

1. Power Quality – by R.C. Duggan
2. Power system harmonics – by A.J. Arrillga
3. Power electronic converter harmonics – by Derek A. Paice
4. Power Electronics –Mohan,Undeland,Robbins
5. Heydt, G.T., „Electric Power Quality", Stars in a Circle Publications, Indiana,2nd edition 1994.
6 .Bollen, M.H.J., „Understanding Power Quality Problems: Voltage sags and interruptions", IEEE Press, New York, 2000.
7. Arrillaga, J, Watson, N.R., Chen, S., „Power System Quality Assessment", Wiley, New York, 2000.

## **MEPS 204** TRANSIENT OVER VOLTAGES IN POWER SYSTEMS

**Unit-1:** Transients in electric power systems – Internal and external causes of over voltages-– Lightning strokes – Mathematical model to represent lightning, Travelling waves in transmission lines – Circuits with distributed constants – Wave equations – Reflection and refraction of travelling waves – Travelling waves at different line terminations.

**Unit- 2:** Switching transients –double frequency transients – abnormal switching transients – Transients in switching a three phase reactor- three phase capacitor.

**Unit-3:** voltage distribution in transformer winding – voltage surges-transformers – generators and motors, Transient parameter values for transformers,reactors,generators and transmission lines.

**Unit-4:** Basic ideas about protection –surge diverters-surge absorbers-protection of lines and stations Modern lighting arrestors,Insulation coordination,Protection of alternators and industrial drive systems.

**Unit- 5**Generation of high AC and DC-impulse voltages,currents-measurement using sphere gaps-peak vpltmeters-potential dividers and CRO.

**References:**

1. Allen Greenwood, „Electrical transients in power systems‟, Wiley Interscience, 1991. 2. Bewley, L.W., „Travelling waves and transmission systems‟, Dover publications, New York, 1963. 3. Gallaghar, P.J. and Pearmain, A.J., 'High voltage measurement, Testing and Design', John Wiley and sons, New York, 2001.
EE615G – ANALYSIS AND DESIGN OF ART

# MEPS 205 Power System Securities and Deregulation

**Unit-1: Basic Concepts:** Power system stability, security, observability, reliability, deregulation, decomposition and multilevel approach, state estimation, system monitoring, static and dynamic – online and offline, security enhancement.

**Unit-2: Power System Deregulation:** Introduction, motivation for restructuring of power systems, Electricity market entities model benefits of deregulation, deregulation in Indian power sector, Operations in power Markets, power pools, transmission networks and electricity markets.

**Unit-3: Power System Security:** Introduction, Factors affecting power system security, Contingency analysis, Detection of network problems, linear sensitivity analysis, AC power flow methods, contingency selection, Bounding area method.

**Unit-4: Power system security assessment:** Network sensitivity factors, performance indices, security constrained optimization, SCOPF, basis of evolutionary optimization techniques, preventive, emergency and restorative controls though non- linear programming (NLP) and linear programming (LP) methods.

**Unit-5: Available Transfer Capability:** Methods of determination of ATC, ATC calculation considering the effect of contingency analysis, Transmission open access and pricing-cost components of transmission system, transmission pricing methods, Incremental cost based transmission pricing.

**References:**

1. A.J.Wood & B.F.Woollenberg- John Wiley Power Generation, “Operation and Control”-2nd edition.
2. P.Venkatesh. B.V.Manikandan, S.Charles Raja- A.Srinivasan, “Electrical power systems:Analysis, security, Deregulation”– PHI2012.
3.K.Bhattacharya, M.H.J Bollen and J.E. Daaider, “Operation of restructured power system” Kluwer Power Electronics and Power System series (2001)
4.N.S.Rau,”Optimization Principles: Practical Applications to the operation and Markets of the Electric Power Industry”.
5.Sally Hunt, “Making competition work in Electricity”, John Wiley, 2002