# M. Tech. Power Systems and Power Electronics

Curriculum Structure and Evaluation Scheme (NEP 2020)
To be implemented for 2025-27 and 2026-28 Batch

| F. Y. M. Tech | | | | | | Semester: I | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Course Code | Course | Teaching Scheme | | | | Evaluation Scheme | | | | | |
| | | L | T | P | Credits | Scheme | Theory Marks | | | Practical Marks | |
| | | | | | | | Max | Min. % for passing | | Max | Min. % for passing |
| EPP1013 | Computer Aided Power System Analysis | 3 | 1 | -- | 4 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| EPP1023 | Electric and Hybrid Electric Vehicles | 3 | -- | -- | 3 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| EPP1043 | Advanced Power Electronics Systems | 3 | 1 | -- | 4 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| | Program Elective - I | 3 | -- | -- | 3 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| | Program Elective - II | 3 | -- | -- | 3 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| EPP1103 | Renewable Energy Lab | -- | -- | 2 | 1 | ISE | -- | -- | | 50 | 50 |
| | | | | | | ESE | -- | -- | | 50 | 50 |
| EPP113 | Electric Vehicle Lab | -- | -- | 2 | 1 | ISE | -- | -- | | 50 | 50 |
| | | | | | | ESE | -- | -- | | 50 | 50 |
| SHP5513 | Technical Communication | 2 | -- | -- | 1 | ISE | -- | -- | | 100 | 50 |
| | **TOTAL** | **17** | **2** | **4** | **20** | | | | | | |

**Total Contact Hours/week: 23**

**Total Credits: 20**

ISE = In Semester Evaluation, ESE = End Semester Exam

**Program Elective-I**

| Sr. No. | Course Code | Course |
|---|---|---|
| 1. | EPP1033 | Wind and Solar Energy Technology |
| 2. | EPP1053 | Distribution Automation |
| 3. | EPP101 | Artificial Intelligence for Power System |
| 4. | EPP102 | Special Electrical Machines and Drives |

**Program Elective-II**

| Sr. No. | Course Code | Course |
|---|---|---|
| 1. | EPP1063 | HVDC Transmission System |
| 2. | EPP1073 | FACTS |
| 3. | EPP1083 | Smart Grid Technologies |
| 4. | EPP103 | Power System Reliability |

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Rajarambapu Institute of Technology Electrical Engg. Department Rajaramnagar

M. Tech. Power Systems and Power Electronics

Curriculum Structure and Evaluation Scheme (NEP 2020)

To be implemented for 2025-27 and 2026-28 Batch

| **F. Y. M. Tech** | | | | | | **Semester: II** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Course** | **Teaching Scheme** | | | | **Evaluation Scheme** | | | | | |
| | | **L** | **T** | **P** | **Credits** | **Scheme** | **TheoryMarks** | | | **Practical Marks** | |
| | | | | | | | Max | Min. % for passing | | Max. | Min. % for passing |
| EPP2023 | Advanced Control of Electric Drives | 3 | 1 | -- | 4 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| EPP2053 | Power System Optimization | 3 | 1 | -- | 4 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| | Program Elective – III | 3 | -- | -- | 3 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| | Program Elective – IV | 3 | -- | -- | 3 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| EPP2093 | Research Methodology & IPR | 2 | 1 | -- | 3 | ISE | 30 | 40 | 40 | -- | -- |
| | | | | | | ESE | 70 | 40 | | -- | -- |
| EPP2103 | Advanced Power System Protection Lab | -- | -- | 2 | 1 | ISE | -- | -- | | 50 | 50 |
| | | | | | | ESE | -- | -- | | 50 | 50 |
| EPP2113 | Advanced Electric Drives Lab | -- | -- | 2 | 1 | ISE | -- | -- | | 50 | 50 |
| | | | | | | ESE | -- | -- | | 50 | 50 |
| EPP121 | Seminar | -- | -- | 2 | 1 | ISE | -- | -- | | 100 | 50 |
| | **TOTAL** | **14** | **3** | **6** | **20** | | | | | | |

**Total Contact Hours/week: 23**
**Total Credits: 20**

ISE = In Semester Evaluation, ESE = End Semester Exam

**Program Elective-III**

| Sr. No. | Course Code | Course |
|---|---|---|
| 1 | EPP2013 | Power System Stability and Dynamics |
| 2 | EPP2033 | Grid Integration of Renewable Energy Sources |
| 3 | EPP2043 | Digital Protection of Power System |
| 4 | EPP201 | High Power Converter Topologies and Control |

**Program Elective-IV**

| Sr. No. | Course Code | Course |
|---|---|---|
| 1 | EPP2063 | Power System Restructuring |
| 2 | EPP2073 | Power Quality and Harmonics |
| 3 | EPP2083 | Energy Storage Systems |
| 4 | EPP202 | Machine Learning Applications in Power Engineering |

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| **S. Y. M. Tech** | | | | | | **Semester: III** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Course** | **Teaching Scheme** | | | | **Evaluation Scheme** | | | | |
| | | **L** | **T** | **P** | **Credits** | **Scheme** | **Theory Marks** | | **Practical Marks** | |
| | | | | | | | Max | Min. % for passing | Max | Min. % for passing |
| EPP3013 | Industry Internship | -- | -- | -- | 1 | ISE | -- | -- | 100 | 50 |
| | Open Elective | 3 | -- | -- | 3 | ESE | 100 | 40 | -- | -- |
| EPP3023 | Dissertation Phase - I | -- | -- | 12 | 6 | ISE | -- | -- | 100 | 50 |
| EPP3033 | Dissertation Phase - II | -- | -- | 20 | 10 | ISE | -- | -- | 100 | 50 |
| | | | | | | ESE | -- | -- | 100 | 50 |
| | **TOTAL** | **3** | **--** | **32** | **20** | | | | | |

**Total Contact Hours/week: 35**
**Total Credits: 20**

ISE = In Semester Evaluation, ESE = End Semester Exam

**Open Elective**

| Sr. No. | Course Code | Course |
|---|---|---|
| 1. | MOE2012 | Artificial Intelligence and Machine Learning |
| 2. | MOE2022 | Creative Thinking: Techniques and Tools |
| 3. | MOE2032 | MOOC Course |
| 4. | MOE2041 | Energy Audit and Management |
| 5. | MOE2062 | Augmented Reality and Virtual Reality |
| 6. | MOE2072 | Industrial Instrumentation |
| 7. | MOE2082 | Advanced Mechatronics systems |
| 8. | MOE2091 | Disaster Management |

## Note for Open Elective

An Open Elective course is included in the curriculum of S. Y. M. Tech (Semester-III), under which students need to learn either MOOC course or courses offered by department.

**Guidelines for MOOC course under Open Elective**

1. If students opt for MOOC course as an Open Elective, he/she should select this course from NPTEL platform only.
2. As three credits are allotted to open elective, selected MOOC course must be of minimum 6 weeks or 30 hours.
3. Students need to solve assignments given by platform and also, give the final certification exam at allotted NPTEL exam center.
4. Student must secure certification of NPTEL platform within program duration, otherwise he/she will not beeligible for final evaluation.
5. If student fails in NPTEL certification course, he or she should reregister for the course in the next semester.

**Guidelines for other courses mentioned under Open Elective:**

1. Student can opt for courses mentioned in the curriculum.
2. While selecting the course, students must take care that selected course from the list is not learned in UG or PG first year curriculum.
3. Lectures of these courses will be conducted by concerned department faculty by online mode.
4. Evaluation of these courses will be as mentioned in the curriculum.

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| **S. Y. M. Tech** | | | | | | **Semester: IV** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Course** | **Teaching Scheme** | | | | **Evaluation Scheme** | | | | |
| | | | | | | | **Theory Marks** | | **Practical Marks** | |
| | | **L** | **T** | **P** | **Credits** | **Scheme** | Max | Min.% for passing | Max | Min.% for passing |
| EPP4013 | Dissertation Phase - III | -- | -- | 16 | 08 | ISE | -- | -- | 100 | 50 |
| EPP4023 | Dissertation Phase - IV | -- | -- | 24 | 12 | ISE | -- | -- | 100 | 50 |
| | | | | | | ESE | -- | -- | 100 | 50 |
| | **TOTAL** | | -- | **40** | **20** | | | | | |

**Total Contact Hours/week: 40**
**Total Credits: 20**

ISE = In Semester Evaluation, ESE = End Semester Exam

| | |
|---|---|
| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
| Course Code: **EPP1013** | Course Name: **Computer Aided Power System Analysis** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | 1 | -- | 4 |

**Course Description:**
The course "Computer Aided Power System Analysis" equips postgraduate students with advanced computational methods and tools for modeling, analyzing, and solving complex power system problems. It focuses on modern techniques for load flow, fault analysis, stability studies, and optimal power flow, integrating renewable energy sources and addressing the challenges of hybrid AC/DC networks. The course emphasizes hands-on experience with suitable software tools. Students will explore emerging topics like harmonic analysis, power quality, and cyber-physical systems in smart grids. Through research-oriented learning and practical applications, the course prepares students for solving real-world challenges in modern power systems and pursuing cutting-edge research in the field.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Model and simulate power system components and networks using advanced computational tools.
2. Perform load flow, fault, and stability analyses for complex and renewable-integrated power systems.
3. Apply optimization techniques for solving economic dispatch and optimal power flow problems.
4. Analyze the impact of power electronics, harmonics, and power quality issues in hybrid power systems.
5. Develop innovative solutions for modern challenges, including cyber-physical systems and renewable energy integration in smart grids.

**Prerequisite:**
Power system analysis, power system operation and control, Mathematics

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction to Power System Analysis and Computational Tools:** Overview of Power Systems: Components, operation, and control of modern power systems. Role of Computer-Aided Analysis: Importance, tools, and software for power system analysis. Matrix Representations in Power Systems: Bus admittance matrix, bus impedance matrix, and incidence matrices. | 06 |

| | | |
|---|---|---|
| 2. | **Advanced Load Flow Analysis:** Fault Review of Load Flow Techniques: Newton-Raphson, Fast Decoupled Load Flow (FDLF), and Distributed Load Flow methods. AC and DC Load Flow: Incorporating DC systems into load flow studies. Power Flow in Renewable Integrated Systems. | 06 |
| 3. | **Fault Analysis in Complex Networks:** Advanced Symmetrical and Unsymmetrical Fault Analysis: In-depth analysis of faults in hybrid AC/DC networks. Impact of Distributed Generation (DG): Fault current contribution of inverter-based sources and its effects on protection schemes. | 06 |
| 4. | **Stability Analysis in Modern Power Systems:** Transient Stability: Multi-machine stability analysis and advanced numerical solutions to the swing equation. Voltage Stability: Factors affecting voltage stability and advanced methods to analyze it. | 06 |
| 5. | **Harmonic Analysis in Modern Power Systems**: State Estimation in Power Systems: Concepts, algorithms, and applications. Harmonic Analysis: Impact of power electronics on power quality and harmonic distortion analysis. Design of advanced filters. | 06 |
| 6. | **Emerging Topics in Power System Analysis**: Cyber-Physical Systems in Power Grids: analysis of cyber-attacks and their impact on power systems. Integration of Microgrids: Protection and control of interconnected microgrids in real-time. | 06 |

**References -**

**Text Books:**

- Kusic, G., Computer-aided power systems analysis. CRC Press.
- Pai, M.A. and Chatterjee, D., Computer techniques in power system analysis. McGraw-Hill Education (India).

**Reference Books:**

- Kothari, D. P., & Nagrath, I. J., Modern Power System Analysis, McGraw Hill Education
- Chakrabarti, A., Halder, S., & Mukhopadhyay, A. K., Power System Analysis: Operation and Control, PHI Learning
- Arrillaga, J., Watson, N. R., & Chen, S., Power System Dynamics: Stability and Control, Wiley-IEEE Press.

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| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I | L | T | P | Credits |
|---|---|---|---|---|---|
| Course Code: **EPP1023** | Course Name: **Electric and Hybrid Electric Vehicles** | 3 | -- | -- | 3 |

**Course Description:**
This course is a core course in F.Y. M. Tech program. This course introduces the fundamental concepts, principles, analysis and design of electric and hybrid electric vehicles.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Discuss the trends and philosophy of electric vehicles
2. Analyze Conventional Vehicles and Powertrains
3. Discuss the electric drive mechanism.
4. Classify hybrid electric vehicles
5. Differentiate Electric and range-extended electric vehicles
6. Describe plug-in hybrid electric vehicles and electrical infrastructure

**Prerequisite:**
Electric machines, Power electronics, Power Systems

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction to Electric Vehicles**: Engineering philosophy of EV development, Overview of EV Challenges, Pure Electric Vehicle, Hybrid Electric Vehicle, Gridable Hybrid Electric Vehicle, Fuel-Cell Electric Vehicle, Overview of EV Technologies, Motor Drive Technology Energy Source Technology, Battery Charging Technology, Vehicle-to-Grid Technology. | 06 |
| 2. | **Fundamentals of Conventional Vehicles and Powertrains**: EV configurations, EV Parameters, Longitudinal Vehicle Model, Longitudinal Resistance, Total Tractive Force, Maximum Tractive Effort and Powertrain Tractive Effort, Vehicle Performance, Braking Performance and Distribution, Vehicle Power Plant and Transmission Characteristics. | 06 |
| 3. | **Electric Propulsion Machines**: Machine specifications, DC Machine, equivalent circuits and equations, Using DC Machine for EV Powertrain, Permanent Magnet Brushless Motor Drives, Surface-Permanent-Magnet AC Machines, Interior-Permanent-Magnet AC Machine, Switched Reluctance Motor Drives, Applications of drives in EV. | 06 |

| | | |
|---|---|---|
| **4.** | **Hybrid Electric Vehicles**: Introduction to Hybrid Electric Vehicles and Hybrid Electric Powertrains, series hybrid, parallel hybrid, power split hybrid, Introduction to Hybrid Powertrain Components, Regenerative Braking Systems, Introduction to Hybrid Powertrain Controls, Driving Cycles and road conditions, fuel economy, HEV Technologies, Classification Based on Their Powertrain System, Challenges in HEV Design and Realization, Plug-In Hybrid Electric Vehicles. | **06** |
| **5.** | **All-Electric Vehicles and Range-Extended Electric Vehicles**: EV Performance Range-Extended Electric Vehicle Range Extenders, Range Extender Connection, Fuel Cell Electric Vehicle, Fuel Cell Electric Vehicle Introduction, Fuel Cell Electric Vehicle Powertrain, Solar Electric Vehicle Solar Electric Vehicle Powertrains, Solar-Powered Charging Station, Electric Bicycle Electric Bicycle Propulsion System, Electric Bicycle Power Distribution. | **06** |
| **6.** | **Plug-In Hybrid Electric Vehicles and Electrical Infrastructure:** Introduction, Components of PHEVs, Operating Principles of Plug-in Hybrid Vehicle, Plug-In Hybrid Vehicular Architecture, Fuel Economy of PHEVs, power management, component sizing, Control Strategy of PHEV, PHEV-Related Technologies and Challenges, PHEV Market, EV and PHEV charging infrastructures , Requirements of EV/PHEV Batteries, power electronics for PEV charging, grid tied home and public systems, EV battery charging specifications and safety issues ,charging modes, V2G and V2G technology. impact of Charging and V2G power flow on the grid. | **06** |

**References –**

**Text Books:**


- K. T. Chau, Electric vehicle Machines and drives Design, analysis and application, Wiley
- Ali Emad, Advanced Electric Drive Vehicles - CRC Press
- C. C. Chan, K. T. Chau - Modern Electric Vehicle Technology, Oxford University Press
- Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles John GHayes, G Abas Goodrazi , John Wiley & Sons


**Reference Books:**


- Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press
- Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press
- James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
|---|---|
| Course Code: **EPP1043** | Course Name: **Advanced Power Electronics systems** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | 1 | -- | 4 |

**Course Description:**

This course is introduced to cater the students so they learn the analysis and control methods of power electronics circuits with converting and controlling of electric power. This course deals with switch mode power converters operation, modeling, and design. Different control strategies for converters. Course covers grid-connection of converters and related emerging technologies. Analysis of power electronics circuit requires consideration of transient response in a very wide range of time scale from a utility grid period of 20 msec to a switching transition of several hundred Nano seconds. This course presents some analysis and modeling methods to solve the dynamic response of the power electronics converters effectively.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Select a power electronic switch for the converter based on its configuration and design consideration.
2. Compare performance of different types of power electronic converters
3. Analyze different types of power converters with respect to their working, circuit configuration, waveforms and performance parameters.
4. Model different types of power converters mathematically.
5. Design power electronic converter for specific application.

**Prerequisite:**

Power electronics, power quality, power system harmonics.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Power Electronic Devices and Switches:** Advanced solid-state devices: MOSFETs, IGBT, GTO, IGCT etc. Wide band gap devices (SiC and GaN) Power modules, intelligent power modules, gating circuits. Design of snubbers Thermal design, protection. Selection of switches, Classification of switches, Generic switch converter, switch matrix. | 06 |
| 2. | **DC – DC Converters:** Review of chopper configurations, Principles of step up and step-down converters, analysis and state space modelling of Buck, Boost, Buck-Boost, cuk and sepic converter. | 06 |
| 3. | **Inverters:** Review of inverter configurations, Performance parameters, Single phase and three phase inverters, various (sine PWM, SVPWM and advanced | 06 |

| | | |
|---|---|---|
| | modulation) control strategies, Multilevel inverters Concept and Types: Diode clamped, Flying capacitor, Cascaded types with applications. | |
| **4.** | **Switched Mode Power Conversion:** Analysis and state space modelling of fly back, Forward, Half bridge and full bridge converters, control circuits for converters and PWM techniques. | **06** |
| **5.** | **Resonant Converters:** Introduction, need of resonant converters, classification of resonant converters, concept of soft switching, Zero Current Switching (ZCS) and Zero voltage switching (ZVS) converters, clamped voltage topologies. | **06** |
| **6.** | **Power Quality Improvement Using Power Electronic Conditioners:** Harmonic propagation and solutions for harmonics, Mitigation of harmonics through filters - Passive filters, active filters and hybrid filters - DSTATCOM, DVR, UPQC. | **06** |

**References -**

**Text Books:**

- M. H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson.
- Ned Mohan, Power Electronics: Converters, Applications and Design, Wiley.

**Reference Books:**

- Bin Wu, High Power Converters and AC Drives, John Willey & sons, Inc.
- P. C. Sen, Modern Power Electronics, S. Chand and Co. Ltd., New Delhi
- Kjeld Thorborg, Power Electronics In theory and Practice, Overseas Press

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | **Semester-I** |
|---|---|
| Course Code: **EPP1033** | Course Name: **Wind and Solar energy Technology** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**
The generation of electricity from wind turbine generators and solar PV has increased during recent years due to environmental concerns as well as due to depletion of fossil fuel. These two technologies have been accepted due to technological development in the field of material science, power electronics and low-cost computers. Both these resources are integrated to power grid which is dominated by thermal power plants and hence the operation of power grid needs to be controlled by considering stochasticity of these resources. Hence there is need to study these technologies from the perspective of operation and control. This will introduce students about basics of wind and solar PV systems as well as economic analysis associated with these resources.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Describe the principle of energy generation from wind and solar PV systems
2. Formulate wind and solar energy systems by mathematical equations
3. Assess energy produced from wind and solar energy systems.
4. Compare the different methods of energy generation from wind and energy systems
5. Develop economic analysis of a wind turbine and solar PV systems

**Prerequisite:**
Power system, power semiconductor devices, electronic circuits and circuit theory.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Solar Energy-Basic Concepts:** Introduction, Radiation Spectrum, Extraterrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation. Measurement of Solar Radiation, Solar Radiation Data, Solar Time, Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Terrestrial Solar Radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface. | 06 |
| 2. | **Solar Photovoltaic Systems:** Introduction, Solar Cell Fundamentals & Characteristics, Solar Cell Classification & Technologies, Solar Cell, Module, and Array Construction, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications. | 06 |

| | | |
|---|---|---|
| 3. | **Economic Analysis of Various Solar Thermal Systems:** PV system and evaluation of solar thermal energy storage system, selection of components and materials, estimation of economics. Using software tools for design of solar thermal and photovoltaic systems, case studies. | 06 |
| 4. | **Wind Energy System:** Speed and power relations, power extracted from the wind, rotor-swept area, air density, wind speed distribution, Weibull probability distribution, energy distribution, wind data analysis and resource estimation, wind turbine energy production estimates using statistical techniques, regional wind resource assessment, wind prediction and forecasting, wind measurement and instrumentation. | 06 |
| 5. | **Wind Energy Conversion Technology:** Synchronous/ asynchronous generators, winding/ permanent magnetized generators, constant/ variable speed, transformers, power electronics, power converters. Design, horizontal and vertical axis wind turbines, blades, control mechanisms, drive train, tower, nacelle, foundation, choice of materials, manufacture, adaptation to different climates control targets, system modelling, control strategies (pitch and stall regulation), wind power parks, transports, erection, grid connection, operation, maintenance. | 06 |
| 6. | **Economic Analysis of Wind Energy Systems:** Financing, investment, costs during the life time of a wind turbine, value of wind energy, business and market overview, environmental issues, law, forms of government support, technical aspects of environment, small scale wind power: technology, economy, paths of development. | 06 |

**References –**

**Text Books:**


- Patel, Mukund R. Wind and solar power systems: design, analysis, and operation. CRC press.


**Reference Books:**


- Kalogirou. S.A, Solar Energy Engineering: Processes and Systems, Academic Press.
- Foster, R.; Ghassemi, M.; Cota, A. Solar Energy: Renewable Energy and the Environment; CRC Press, Taylor & Francis Group: Boca Raton, FL, USA.
- Manwell, James F., Jon G. McGowan, and Anthony L. Rogers. Wind energy explained: theory, design and application. John Wiley & Sons.

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
|---|---|
| Course Code: **EPP1053** | Course Name: **Distribution Automation** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**

This course is introduced to cater the students so they will learn the planning, design, analysis and operational concepts of the distribution system, including considerations of voltage regulation, protection, and reliability as well as application of distributed generation and smart grid technology. Upon completion of the course, students will be able to plan, model, study, and design distribution systems and associated equipment and devices. The structure and load patterns of a power distribution system are significantly different than transmission system. In addition, distribution systems are transitioning from passive to active with the adoption of distributed generation, storage, and smart-grid technologies. Therefore, the analysis tools developed for a transmission system will not be directly applicable to a distribution network.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Prepare layout of the substations and feeders considering load and desired voltage
2. Design distribution system and associated equipment and devices.
3. Identify an appropriate method of communication for any particular distribution system with a view of automation and SCADA
4. Analysis distribution feeder components.
5. Model the different distribution feeder components.

**Prerequisite:**

Power system analysis, communication devices, load flow studies

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Distribution System Planning:** Planning and forecasting techniques, Present and future, Role of computers, definitions, Load forecasting, methods of forecast, regression analysis. Load management, tariffs and metering of energy. | 06 |
| 2. | **Approximate Methods of Analysis-** Computation of transformer and feeder loading, "K" Factors, voltage drop and power loss calculations, distribution of loads and various geometric configurations. | 06 |
| 3. | **Introduction to SCADA-** Monitoring and supervisory functions, SCADA applications in Utility Automation, SCADA System Components, RTU, IED, PLC, Communication Network, SCADA Server, SCADA/HMI Systems, SCADA architectures. | 06 |

| | | |
|---|---|---|
| **4.** | **Voltage Drop and Power Loss Calculations:** Three phase primary lines, Copper loss, Distribution feeder costs, Loss reduction and Voltage improvement in rural networks. | **06** |
| **5.** | **Distribution Feeder Analysis:** Power-Flow Analysis, the Ladder iterative technique, Linear network, Nonlinear network, the general Feeder, unbalanced three-phase Distribution Feeder, Series components, Shunt components. Applying the Ladder iterative techniques for load allocation. | **06** |
| **6.** | **Modeling of Distribution System Components**: Overhead lines, feeders and cables, Single and three phase distribution transformers, Voltage regulators. Load models, Capacitor banks, Distributed generation. | **06** |

**References -**

**Text Books:**


- Turan Gonen, Electric Power Distribution system, Engineering Mc Graw-hill Book Company.
- William H. Kersting, Distribution System Modeling and Analysis, CRC press.


**Reference Books:**


- W. H. Kresting, Distribution System Modeling and Analysis, CRC Press, New York.
- A.S. Pabla, Electric Power Distribution, Tata Mc Graw-hill Publishing company.
- Debapriya Das, Electrical Power Systems, New Age International.

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | **Semester-I** |
|---|---|
| Course Code: **EPP101** | Course Name: **Artificial Intelligence for Power Systems** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**

The course explores the fundamentals of artificial intelligence (AI) and its increasing applications in power system monitoring, operation, and control. Students will gain a comprehensive understanding of AI methodologies, including Artificial Neural Networks (ANN) and Fuzzy Logic theory, and their practical implementations in addressing complex challenges within power systems. The curriculum emphasizes the use of AI techniques for fault diagnosis, power system state estimation, and the design of intelligent controllers. At the end of the course, participants will acquire the knowledge and skills to apply AI-driven solutions for enhancing the reliability, efficiency, and performance of modern power systems.

**Course Outcomes:**

After successful completion of the course, students will be able to,
1. Explain the role of artificial intelligence in enhancing power system monitoring, operation, and control.
2. Analyze the principles and functioning of Artificial Neural Networks (ANN) and Fuzzy Logic in power system applications.
3. Design AI-based solutions for fault diagnosis, state estimation, and intelligent control in power systems.
4. Evaluate the performance and reliability of AI-driven models applied to power systems.
5. Integrate AI techniques into real-world power system scenarios to improve efficiency and resilience.

**Prerequisite:**

Power system, mathematics.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Notions of Artificial Intelligence:** Introduction to Artificial Intelligence, Introduction to Artificial Neural Network (ANN), Fuzzy systems, Expert Systems, Genetic Algorithm, Evolutionary Programming. Use of expert systems in power system monitoring operation and control. | 06 |
| 2. | **Artificial Neural Network (ANN):** Introduction, Biological neurons, Function of single biological neuron, function of artificial neuron, Basic terminology related to artificial neuron. Characteristics of ANN, Typical applications of ANN such as classification, pattern recognition, forecasting properties, strength of ANN. | 06 |

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|---|---|---|
| **3.** | **Neural Network Architectures:** Types of activation function, Learning Tasks, Single Layer Network and Multi-layer Network, learning curves, Learning Rate, Annealing techniques. Feed forward Neural Network, Back propagation algorithm. Limitation of Back propagation algorithm. Application of Neural Network in Power System. | **06** |
| **4.** | **Fuzzy Mathematics:** Basic concept of Fuzzy Logic, Fuzzy set, Basic definition, Membership function, Operations of fuzzy sets, Fuzzy relations - Fuzzy graphs - Fuzzy analysis Propositional logic, predictive logic, Fuzzy set theory. | **06** |
| **5.** | **Genetic Algorithms and Evolutionary Programming:** Introduction, Genetic Algorithms, Procedure of Genetic Algorithms, Genetic Representations, Initialization and Selection, Genetic Operators, Mutation, The Working of Genetic Algorithms, Evolutionary Programming, The Working of Evolutionary Programming. Intelligent Systems for Demand Forecasting. | **06** |
| **6.** | **Applications of AI in Power Systems:** Expert systems in fault diagnosis and voltage control. Applications of Neural network-based power system estimators and controllers. Fuzzy logic-based controllers. Alarm analysis and decision-making processes. Application of ANN for security assessment, Schedule Maintenance of Electrical Power Transmission Networks using Genetic Algorithm. | **06** |

**References –**

**Text Books:**

- Padhy N.P., Artificial Intelligence and Intelligent Systems, OXFORD University Press.
- Warwick Kevin; Arthur Ekwue; Raj Aggarwal, Artificial Intelligence Techniques in Power Systems, IET Power Engineering Series.

**Reference Books:**

- Simon Haykin, Neural Networks: A Comprehensive Foundation, Pearson Education.
- El-Hawary M.E., Electric Power Applications of Fuzzy Systems, Wiley-IEEE Press.
- Kartalopoulos S.V., Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications, Wiley-IEEE Press.

| | |
|---|---|
| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
| Course Code: **EPP102** | Course Name: **Special Electrical Machines and Drives** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**

Special electrical machines are being used more and more in areas like position control systems, robotics, mechatronics, electric vehicles, and high-speed transportation. They play an important role in industries such as production, processing, fabrications and renewable energy applications, etc. Some special electrical machines have higher efficiency, small size and useful for specific applications. This course not only explains the basic principles of these advanced machines but also covers the latest developments and ongoing research. It is especially helpful for post graduate students and researchers studying electrical machines and drives.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Analyze the performance characteristics of in traction motors.
2. Evaluate the performance characteristics of stepper motors.
3. Evaluate the performance characteristics of servo motors.
4. Analyze electromagnetic behavior, inductance profiles, and torque production in SRMs.
5. Estimate the performance parameters of PMBLDCM under different operating conditions.
6. Analyze the performance characteristics and operating conditions of fractional kilowatt motors and LIM in various applications.

**Prerequisite:**

Engineering Mathematics.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Electric Motors for Traction Drives:** The different types of electric motors used for traction, including DC series, reluctance, alternating current (AC), and permanent magnet synchronous motors (PMSM), modern trends in drives technology, Attractive effort for acceleration and propulsion, AC motors– DC motors. Single sided linear induction motor for traction drives. Comparison of AC and DC traction. | 06 |
| 2. | **Stepper Motors:** Constructional features, principle of operation, Types of stepper motors: VR Stepper motor, PM stepper motor, Hybrid stepper motor, torque production in VR stepper motor, modes of excitation, Dynamic | 06 |

| | | |
|---|---|---|
| | characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor, Design and Applications. | |
| 3. | **Servo Motors:** Constructional features, principle of operation, Types of servo motors: Symmetrical components applied to two-phase servo motors, equivalent circuit and performance based on symmetrical components - servo motor torque-speed curves. | **06** |
| 4. | **Switched Reluctance Motors:** Constructional features, principle of operation, design, steady state performance, methods for inductance calculation, Torque equation, Power converters, speed torque characteristics, closed loop control for Switched Reluctance drives, current and torque control, acoustic noise control, sensor-less operation, applications. | **06** |
| 5. | **Brushless DC Motors**: Commutation in DC motors, difference between mechanical and electronic Commutators, Hall sensors, Optical sensors, Multi phase Brushless motor, Square Wave permanent magnet brushless motor drives, torque and EMF equation, torque speed characteristics of Permanent Magnet Brushless DC Motors, controllers. PMDC Motor, sine wave permanent magnet brushless motor drives, Applications. | **06** |
| 6. | **Fractional KW Motors & Linear Induction Motors:** Universal motor, reluctance motor, hysteresis motor, repulsion motor, essential parts, performance characteristics, construction, working, and application, Linear induction motor: Construction, principle of operation and applications. | **06** |

**References –**

**Text Books:**


- K. Venkata Ratnam, Special Electrical Machines, University press, New Delhi.
- Hughes, Electric Motors & Drives, Newnes.
- E.G. Janardhanan, Special Electrical Machines, PHI Learning private limited


**Reference Books:**


- Kenjo.T, Stepping Motors and their Microprocessor Control, Clarendon Press, Oxford.
- Kenjo. T and Nagamori. S, Permanent Magnet and Brushless DC Motors, Clarendon Press, Oxford.
- Krishnan R. Switched Reluctance Motor Drives, Modelling, Simulation, Analysis, Design and applications, CRC press.
- Ion Boldea, Linear Electric Machines, Drives, and MAGLEVs Handbook, CRC Press, Taylor & Francis Group, New York

| | |
|---|---|
| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | **Semester-I** |
| Course Code: **EPP1063** | Course Name: **HVDC Transmission System** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**

This course provides a comprehensive of HVDC transmission systems, covering the fundamental concepts, design, operation, and control techniques. It explores the historical development and modern trends in HVDC technology, including a detailed comparison with HVAC systems. Students will learn about the various types of HVDC converters, their operation, and pulse-width modulation techniques. The course delves into critical aspects such as converter faults, protection mechanisms, harmonics, and the role of filters in ensuring system stability. Additionally, the course introduces multi-terminal HVDC systems, focusing on their applications, control strategies, and protection schemes. By the end of the course, students will gain in-depth knowledge essential for working in HVDC system design, maintenance, and innovation.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Elaborate HVDC transmission system merits, types, and structure.
2. Analyze HVDC converters and their control strategies.
3. Explain various faults and their protection technique in HVDC systems.
4. Design AC and DC harmonic filters to mitigate harmonics in HVDC systems.
5. Develop mathematical models of HVDC systems under various operating conditions.

**Prerequisite:**

Power Electronics, Power Systems, Switchgear and Protection, Power Quality

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **HVDC Transmission Systems:** Historical development, Comparison of HVDC & HVAC transmission system, Type of HVDC links, Converter station structure, Applications of HVDC transmission, Modern Trends in HVDC technology, Multi Terminal HVDC systems. | 06 |
| 2. | **HVDC Converters:** Selection of semiconductor valve, Analysis of Line commutated converter – 6 & 12 pulse, Voltage source converter – two & three level, Pulse width modulation techniques. | 06 |

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|---|---|---|
| 3. | **HVDC Converter Control:** Principles of DC link control, Converter control characteristics, System control hierarchy, Firing angle control, Current controller, Excitation angle control. | 06 |
| 4. | **Converter Faults and Protection:** Commutation failure, Arc through, Misfire, Current extinction, short circuit in bridge, Over voltage in converter station. Protection against overcurrent, Protection against overvoltage. | 06 |
| 5. | **Harmonics and Filters:** Introduction, Generation of harmonics, Types of harmonics, Impact of harmonics, Mitigation techniques, Design of AC & DC harmonic filters, Active harmonic filter. | 06 |
| 6. | **Modeling of HVDC Systems:** Mathematical Modeling of HVDC Converters; Converter Transformer Modeling; DC Link Modeling; Control System Modeling; Dynamic Performance Analysis. | 06 |

**References -**

**Text Books:**

- Padiyar K. R., HVDC Power Transmission Systems, New Age international.
- S Kamakshaiah and V Kamaraju, HVDC Transmission, TMH Publications.

**Reference Books:**

- J. Arrillaga, High Voltage Direct Current Transmission, Peter Peregrinus Ltd.
- E. W. Kimbark, Direct Current Transmission, Wiley- Inder-science.
- Vijay K Sood, HVDC and FACTS Controller Springer Publication.

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
|---|---|
| Course Code: **EPP1073** | Course Name: **FACTS** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**
FACTS technology plays a crucial role in enhancing the power flow control, voltage stability, and dynamic response in the modern electrical power system. The main focus of this course is to provide the importance of the transmission interconnections, power flow management, reactive power compensation and voltage stability. This course contains series, shunt and combined series-shunt compensators (SVC, STATCOM, TCSC, UPFC), power flow control, voltage regulation, stability and DVR for power quality compensation.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Justify need of reactive power compensation schemes
2. Illustrate the operational characteristics of Static Shunt Compensators
3. Examine series compensation for voltage and reactive power compensation
4. Illustrate the operation of DVR for power quality improvement
5. Inspect voltage and reactive compensation using combined series and shunt compensators

**Prerequisite:**
Power system, power semiconductor devices, electronic circuits, circuit theory.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **FACTS Concept and General System Considerations:** Need transmission interconnections, opportunities for FACTS, flow of power in an AC system, power flow and dynamic stability considerations of a transmission interconnection, relative importance of controllable parameters basic types of FACTS controllers. | 06 |
| 2. | **Static Shunt Compensators:** Shunt compensation requirement, midpoint voltage regulation for line segmentation, improvement of transient stability, power oscillation damping, variable impedance type static VAR generators, switching converter type VAR generators, TSC and TCR, transfer function and dynamic performance, transient stability enhancement, power oscillation damping, FC-TCR, TSC-TCR, STATCOM. | 06 |

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|---|---|---|
| 3. | **Static Synchronous Series Compensators:** Series compensation principle, GCSC, TCSC, TSSC and SSSC variants: circuit and steady-state characteristic; effect on transmission line compensation; Power oscillation damping, losses, modes of operation of TCSC. | 06 |
| 4. | **Static Voltage, Phase Angle Regulators and DVR:** Voltage and Phase Angle Regulation, Power Flow Control, Real and Reactive Loop Power Flow Control, Transient Stability with Phase Angle Regulators, TCVRs AND TCPARs, Switching Converter-Based Regulators, DVR for power quality compensation, modes of control. | 06 |
| 5. | **Unified Power Flow Compensator (UPFC):** Operation, transmission control capabilities, independent real and reactive power control, basic control scheme, dynamic performance. | 06 |
| 6. | **Interline Power Flow Controller (IPFC):** Operation, IPFC prime converter system, basic two converter IPFC, voltage and reactive compensation lines, Pharos diagrams and PQ planes, control structure. | 06 |

**References -**

**Text Books:**

- Hingorani, N.G. and Gyugyi, L., Understanding FACTS, IEEE Press, New York.
- Mathur, R.M. and Varma, R.K., Thermistor-based FACTS controllers for electrical transmission systems. John Wiley & Sons.

**Reference Books:**

- K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International (P) Ltd. Publishers.
- Arindam Ghosh & Gerard Ledwich, Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers.

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
|---|---|
| Course Code: **EPP1083** | Course Name: **Smart Grid Technologies** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | - | - | 3 |

**Course Description:**

This course is offered as Elective for post graduate students. This course deals with smart grid introduction, technologies, communication and applications of renewable sources for developing smart grid.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Discuss the smart grid in Indian perspective
2. Explain various smart grid technologies.
3. Describe smart meters and advance metering infrastructure.
4. Compare Smart grid and microgrid
5. Apply power quality management in smart grid
6. Identify communication technologies for smart grid

**Prerequisite:**

Fundamentals of Power system, Transmission and distribution system, automation, optimization techniques, Renewable energy sources, power system economics, power quality issues

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction to Smart Grid**: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Drivers of SG in India, Challenges for SG, Difference between conventional & smart grid, Smart Grid Vision & Roadmap for India, Concept of Resilient and Self-Healing Grid, Present development & International policies in Smart Grid, Smart Cities, Pilot projects in India. | 06 |
| 2. | **Smart Grid Technologies:** Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Phase Measurement Unit (PMU). Smart Substations, Substation and Feeder Automation, application for monitoring, protection and control, Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid (V2G), Grid to vehicles (G2V), Smart storage technologies – Battery (flow and advanced), SMES, Super Capacitors, Pumped Hydro, Compressed Air Energy Storage (CAES) and its comparison. | 06 |

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|---|---|---|
| **3.** | **Smart Meters and Advance Metering Infrastructure:** Introduction to Smart Meters, Advanced Metering Infrastructure (AMI), Real Time Prizing, Automatic Meter Reading (AMR), Outage Management System (OMS) Smart Sensors, Smart Appliances, Home & Building Automation, Geographic Information System (GIS). | **06** |
| **4.** | **Microgrid:** Concept of Microgrid, need & applications of Microgrid, Microgrid Architecture, DC Microgrid, Formation of Microgrid, Issues of interconnection, protection & control of Microgrid, Integration of renewable energy sources, Smart Microgrid, Microgrid and Smart Grid Comparison, Smart Microgrid Renewable Green Energy System, Cyber Controlled Smart Grid, Block chain technology and microgrid. | **06** |
| **5.** | **Power Quality Management in Smart Grid:** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. | **06** |
| **6.** | **Communication Technology for Smart Grid:** Communication Architecture of SG, Wide Area Measurement System (WAMS), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid, Broadband over Power line (BPL), IP based protocols. | **06** |

**References –**

**Text Book**

- Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press.
- Gil Masters, Renewable and Efficient Electric Power System, Wiley–IEEE Press.

**Reference Books**

- A.G. Phadke and J.S. Thorp, Synchronized Phasor Measurements and their Applications, Springer Edition.
- T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley.

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| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
|---|---|
| Course Code: **EPP103** | Course Name: **Power System Reliability** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**

The course emphasizes the role of power electronics in enhancing reliability and addresses challenges in modern grids, such as the integration of renewable energy sources and energy storage systems. Key topics include reliability modeling, Markov processes, Monte Carlo simulations, and reliability indices. Course includes reliability standards, tools, and applications in smart grids and microgrids, with assignments.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Explain the fundamentals of reliability engineering and its application in power systems.
2. Analyze the reliability of power system components and networks.
3. Apply probabilistic techniques and tools for system reliability evaluation.
4. Design power systems with enhanced reliability incorporating power electronics and renewable energy.
5. Explore methods to enhance power system reliability in the context of modern power electronics applications

**Prerequisite:**

Engineering Mathematics, Power System.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Fundamentals of Reliability Engineering:** Introduction to Reliability: Definition, importance, and reliability in power systems. Basic Reliability Concepts: Failure rate, mean time to failure (MTTF), mean time to repair (MTTR), availability, and unavailability. Reliability Parameters: Series, parallel, and complex configurations. Reliability Modeling: Block diagrams and fault tree analysis. | 06 |
| 2. | **Reliability Analysis of Power System Components:** Generation System Reliability: Loss of load probability (LOLP), loss of energy expectation (LOEE), and capacity outage probability table (COPT). Transmission and Distribution Reliability: Failure modes, outage data analysis, and indices (SAIFI, SAIDI, CAIDI, ASAI, ASUI). Protection Systems: Impact of relays, circuit breakers, and coordination on system reliability. | 06 |

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|---|---|---|
| 3. | **Probabilistic Methods in Power System Reliability:** Probability Theory Review: Basic probability concepts and random variables. Markov Processes: Markov models for system reliability. Monte Carlo Simulation: Application in power system reliability evaluation. State-Space Representation: Transition diagrams and reliability indices. | 06 |
| 4. | **Power Electronics in Reliability Enhancement:** Role of Power Electronics: Impact of power electronic converters on reliability. Reliability of Inverters: Failure analysis and redundancy techniques. Renewable Energy Integration: Reliability of hybrid power systems with solar and wind sources. Harmonic Impact: Influence of power electronic devices on system reliability. | 06 |
| 5. | **Reliability of Smart Grids and Microgrids:** Smart Grid Reliability: Cyber-physical systems and demand-side management. Microgrid Reliability: Islanding, protection coordination, and load shedding strategies. Energy Storage Systems: Reliability modeling of batteries and ultracapacitors. Resilience and Robustness: Strategies to enhance reliability in modern grids. | 06 |
| 6. | **Reliability Standards, Tools, and Applications:** Reliability Standards: IEEE, NERC, and IEC reliability standards for power systems. Reliability Tools: ETAP, MATLAB, and Python-based reliability analysis tools. Case Studies: Real-world reliability analysis of power systems. Future Trends: Emerging technologies in reliability engineering for power systems | 06 |

**References -**

**Text Books:**


- Roy Billinton and Ronald N. Allan, Power System Reliability Evaluation, Springer.
- Balbir Singh Dhillon, Electric Power System Reliability, Wiley-IEEE Press


**Reference Books:**


- Jerry C. Whitaker, Reliability Engineering and Risk Assessment, 1st Edition, CRC Press
- E. Balagurusamy, Reliability Engineering, McGraw Hill Education
- J. Duncan Glover, Mulukutla S. Sarma, and Thomas J. Overbye, Power System Analysis and Design, Cengage Learning
- Roy Billinton and Weedy, Reliability and Risk Evaluation of Wind Integrated Power Systems, Volume 1, Springer

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
|---|---|
| Course Code: **EPP1103** | Course Name: **Renewable Energy Lab** |

| L | T | P | Credits |
|---|---|---|---|
| - | - | 2 | 2 |

**Course Description:**

Renewable Energy Lab course provides hands-on experience in solar and wind energy technologies. This course emphasizes on operation, performance analysis and efficiency of solar and wind energy.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Prepare report on wind resource assessment
2. Operate and maintain squirrel cage and DFIG based systems
3. Compute reactive power requirement for standalone wind turbine system
4. Demonstrate the effects of shadowing on PV modules
5. List the installation materials for off grid PV systems

| Expt. No | Description | Duration (Hours) |
|---|---|---|
| 1. | To study the wind resource assessment for wind farm layout. | 2 |
| 2. | To emulate of induction generator. | 2 |
| 3. | To emulate of Doubly-fed induction generator. | 2 |
| 4. | To study the stand-alone wind energy generator emulation using squirrel cage induction generator feeding power to the mains. | 2 |
| 5. | To examine the reactive power requirements and power factor correction | 2 |
| 6. | To analyse the I-V and P-V characteristics of PV module with varying radiation and temperature level. | 2 |
| 7. | To analyse the effect of variation in tilt angle on PV module power. | 2 |
| 8. | To examine the effect of shading on module output power. | 2 |
| 9. | To analyse the working of diode as bypass diode and blocking diode. | 2 |
| 10. | To examine the power flow calculations of standalone PV system of DC load with battery | 2 |
| 11. | To examine the power flow calculations of standalone PV system of DC and AC load with battery. | 2 |

**References:**


- Laboratory Manual
- Wilhelm Kirchensteiner –Solar Power Laboratory
- Boyle, Godfrey. Renewable Energy (2nd edition). Oxford University Press, (ISBN:0-19-926178-4).
- Boxwell, Michael: Solar Electricity Handbook: A simple to solar energy – designing and installing photovoltaic solar electric systems.
- Boyle, Godfrey, Bob Everett, and Janet Ramage Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press, (ISBN: 0-19-926179-2).
- Schaeffer, John. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living.
- Freris, Leon and Infield, David. Renewable in power systems

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-I |
|---|---|
| Course Code: **EPP113** | Course Name: **Electric Vehicle Lab** |

| L | T | P | Credits |
|---|---|---|---|
| - | - | 2 | 1 |

**Course Description:**

This course provides a comprehensive hands-on exploration of electric vehicle (EV) systems. Students will engage in practical experiments to analyze key components such as wiring harnesses, battery management systems (BMS), BLDC motors, and charging mechanisms. Through these lab sessions, students will calculate and evaluate performance parameters like power, torque, and power-to-weight ratio while exploring advanced concepts such as speed control and power-split mechanisms in hybrid vehicles. The course emphasizes applied learning, equipping students with the technical skills and knowledge required for EV design, testing, and optimization.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Demonstrate the functioning of an Electric Vehicle (EV) components.
2. Analyze key performance parameters of an Electric Vehicle (EV).
3. Apply control techniques for battery charging, motor speed control, and regenerative braking system.
4. Examine thermal management and hybrid power-split systems in EVs.

**Prerequisite:**

Electrical Machines, Power Electronics, Control Systems, Engineering Chemistry

| Expt. No | Description | Duration (Hours) |
|---|---|---|
| 1. | Introduction to Wiring Harness system of 2W EV | 2 |
| 2. | Demonstrate working of Battery Pack & BMS system | 2 |
| 3. | Estimate Power and Torque of the 2W EV motor. | 2 |
| 4. | Analyze Power to weight ration of EV drive train | 2 |
| 5. | Study CC & CV algorithm to charge and discharge a battery | 2 |
| 6. | Study on-board charger of a two-wheeler vehicle | 2 |
| 7. | Demonstrate speed control of BLDC motor drive | 2 |
| 8. | Study power-split hybrid electric vehicle model | 2 |

| | | |
|---|---|---|
| 9. | Analysis Regenerative Braking system of EV | 2 |
| 10. | Study Thermal Management System of Battery Pack | 2 |

**References:**


- Laboratory Manual
- Mehrdad Ehsani, Yimin Gao, Sebastien Gay, and Ali Emadi "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design" CRC Press
- Davide Andrea "Battery Management Systems for Large Lithium-Ion Battery Packs" Artech House
- Austin Hughes and Bill Drury "Electric Motors and Drives: Fundamentals, Types, and Applications" Butterworth-Heinemann

| Class: **F. Y. M. Tech** | Semester: **I** |
|---|---|
| Course Code: **SHP5513** | Course Name: **Technical Communication** |

| L | T | P | Credits |
|---|---|---|---|
| **02** | **--** | **--** | **01** |

**Course Description:**

This course is designed to enhance students' ability to create well-structured technical documents and deliver impactful oral presentations. It emphasizes the principles of effective technical writing and explores various document types commonly used in technical fields and research. While the primary focus is on writing skills, the course also integrates oral communication skills, preparing students for professional presentations in diverse workplace settings.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Construct grammatically correct sentences in different types of technical writing, such as reports and proposals.
2. Apply technical writing skills to improve readability of documents.
3. Demonstrate professional skills required in job interviews and at workplace.

**Prerequisite:** Students enrolling in this course should have adequate LSRW abilities in English language.

| Course Contents | | |
|---|---|---|
| **Unit No.** | **Description** | **Hrs.** |
| **01** | **Planning and Preparation:**<br>Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. | **04** |
| **02** | **Paraphrasing and Plagiarism:**<br>Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism. | **03** |

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|---|---|---|
| 03 | **Structural Framework of Research Article:**<br>Abstract, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, and The Final Check. | 03 |
| 04 | **Sections of Research Article: Part- I:**<br>Key skills needed when writing a Title, key skills needed when writing an Abstract, key skills needed when writing an Introduction, skills needed when writing a Review of the Literature. | 04 |
| 05 | **Sections of Research Article: Part- II:**<br>Skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills needed when writing the Conclusions, useful phrases, how to ensure good quality of the paper at the time of submission. | 04 |
| 06 | **Professional skills:**<br>Resume Writing, e-Mails, Interview skills, Dos and Don'ts while Answering, FAQs, GROUP DISCUSSION: Structured and Unstructured GD, Opening and Closure, Showing Agreement and Disagreement. | 06 |

**Reference Books:**

**Text Books:**


- Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London.


**Reference Books:**


- Day R, How to Write and Publish a Scientific Paper, Cambridge University Press,
- Goldbort R, Writing for Science, Yale University Press (available on Google Books).
- Jeff Butterfield, Soft Skills for Everyone, Cengage Learning India Private Limited.
- John Seely, Oxford Guide to Effective Writing and Speaking; Oxford University Press.
- Thomas N. Huckin and Leslie A. Olsen, Technical Writing and Professional Communication for Nonnative Speakers of English; Tata McGraw Hills, International Edition.


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| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-II |
|---|---|
| Course Code: **EPP2023** | Course Name: **Advanced Control of Electric Drives** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | 1 | -- | 4 |

**Course Description:**

Electrical drive system mainly consists of source, power electronic converter, and motor and control logic. Lots of advancements are taking place in power electronics and motors. Electrical vehicles is an emerging trend in electrical engineering, for that high efficient motors and converters are needed to increase overall efficiency of vehicle. Most recent motor drives are covered in this course. This course deals with analysis and design of different power electronics converter fed motors. The Operating principles are thoroughly described as well as the design and control of the drive systems.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Justify the need of closed loop drive system for industrial applications.
2. Explain the working principle of different types of drive system.
2. Compare different types of electric drives.
3. Develop mathematical models of electric drive system for specific application.
4. Design controllers for closed-loop operation of different types of electrical motors.

**Prerequisite:**

Power electronics, Machines and Electrical Drives.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Control of Induction Motor Drives:** Review of Induction motor and its characteristics, Starting, braking and Speed control of induction motors, V/F control, Slip power recovery schemes, Effect of VFD on power system, Induction motors applications in electric vehicles. | 06 |
| 2. | **Vector Control of Induction Motors:** Magnetic field systems, Transformer emf and Speed emf, Knon's Primitive Model, Stationary frame dynamic model – ABC and αβ0 reference frame, synchronously rotating reference frame dynamic model (dq0 reference frame), Principal of Vector control, Direct vector control, indirect vector control. | 06 |

| | | |
|---|---|---|
| 3. | **Control of BLDC Motor Drives:** Principle of operation of BLDC Machine, Sensing and logic switching scheme, Sped control of BLDC drive, methods for reducing torque pulsations, sensor less control of BLDC drive, BLDC motor drive for servo applications and electric vehicles. | **06** |
| 4. | **Stepper and Switched-Reluctance Motor Drives:** Introduction to stepper motor, construction and working principle, control of stepper motor, stepper motor drive, Industrial applications. SRM configuration and its controller, converter topologies, Sensor less control, SRM drive design factors, Torque control using current controllers, Industrial applications. | **06** |
| 5. | **Servo Motor Drives:** Introduction to servo mechanism, types of servo motors, analysis, transfer function and block diagram representation of servo motors, servo motor drive, Industrial applications. | **06** |
| 6. | **Energy Conservation in Electrical Drives:** Need for energy conservation, Losses in electrical drive system, compatibility of motor & drives, Effects of drives on motor - dV/dt, THD, Sound & Vibration, Measures for energy conservation in electric drives, Energy efficient operation of drives, Improvement of power factor and quality of supply by various methods. | **06** |

**References -**

**Text Books:**

- P.C. Sen, Principles of Electric Machines and Power Electronics, Third Edition, Wiley
- Bimal K Bose, Modern Power Electronics and AC Drives, Pearson Education

**Reference Books:**

- Electric Motor Drives: Modeling, Analysis, and Control, Prentice Hall publications
- Gopal K Dubey, Fundamentals of the electrical drives, Narosa publication
- Vedam Subrahnyam, Electrical Drives Concept and application, Tata McGraw Hill publication.

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|---|---|
| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-II |
| Course Code: **EPP2053** | Course Name: **Power System Optimization** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | 1 | -- | 4 |

**Course Description:** The power system optimization problems are complex and nonlinear nature. This course includes the study of power system optimization problems such as unit commitment, economic dispatch and optimal power flow. This course also highlights the issues with power system optimization problems.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Explain the need of power system optimization
2. Formulate power system optimization problem
3. Apply numerical and heuristic technique to solve power system optimization problem.
4. Solve power system optimization problem
5. Assess the impact of parameters on defined optimization problem.

**Prerequisite:**
Power system, Electric Circuit Analysis and Mathematics.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction to Power System Optimization:** Overview of Optimization in Power Systems: Nature of optimization problems (nonlinear, discrete, and combinatorial), need for optimization in modern power systems. Classification of Optimization Problems: Linear programming (LP), nonlinear programming (NLP), mixed-integer programming (MIP), and dynamic programming (DP). Optimization Problem Formulation: Objective functions, constraints, decision variables, and solution space. Challenges in Optimization: Scalability, computational complexity, and convergence issues. | 06 |
| 2. | **Economic Load Dispatch and Unit Commitment:** Economic Load Dispatch (ELD): Objective function, cost curves, and equality and inequality constraints. Unit Commitment (UC): Problem formulation, constraints (spinning reserve, ramp rate, minimum up/down time), and solution approaches. Solution Techniques: Classical methods (Lagrange multipliers, priority list) and heuristic approaches for solving ELD and UC. Practical Considerations: Integration of renewable energy sources and handling uncertainties in demand and generation. | 06 |

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|---|---|---|
| 3. | **Optimal Power Flow (OPF):** Introduction to Optimal Power Flow: Problem formulation, objectives (economic, security, environmental), and constraints (equality and inequality). Solution Techniques: Gradient methods, Newton's method, and interior-point methods. Security-Constrained OPF (SCOPF): Contingency analysis and multi-objective optimization. Applications of OPF: Incorporation of renewable energy and FACTS devices in power systems. | **06** |
| 4. | **Numerical Optimization Techniques:** Classical Methods: Linear programming, nonlinear programming, quadratic programming, and dynamic programming. Iterative Techniques: Gauss-Seidel and Newton-Raphson methods for optimization. Multi-Objective Optimization: Pareto-optimality, weighted sum approach, and epsilon-constraint method. Software Tools: MATLAB and GAMS for implementing numerical techniques. | **06** |
| 5. | **Heuristic Optimization Techniques:** Overview of Heuristic Methods: Metaheuristic algorithms and their advantages over classical methods. Popular Algorithms: Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Differential Evolution (DE), and Simulated Annealing (SA). Hybrid Techniques: Combining metaheuristic approaches with numerical methods for improved performance. | **06** |
| 6. | **Case Studies and Emerging Trends in Power System Optimization:** Case Studies: Optimization problems in renewable-integrated power systems, energy storage, and microgrids. Impact of Parameters: Sensitivity analysis of optimization parameters in ELD, UC, and OPF problems. Emerging Trends: Machine learning and AI-based techniques for real-time optimization. Challenges in Modern Power Systems. | **06** |

**References -**

**Text Books:**

- Allen J.Wood and Wollenberg B.F., Power Generation Operation and control, John Wiley & Sons, Second Edition
- Nagrath, I.J. and Kothari D.P., Modern Power System Analysis, TMH, New Delhi

**Reference Books:**

- Olle I Elgard, Electric Energy systems Theory - An Introduction, TMH
- Kirchmayer L.K., Economic Control of Interconnected Systems, John Wiley & Sons

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|---|---|
| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | **Semester-II** |
| Course Code: **EPP2013** | Course Name: **Power System Stability and Dynamics** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**
This is a core course in F.Y. M. Tech. program in Semester II. This course deals with the synchronous machine and analysis of synchronous machine. This will help the student to make a mathematical model of synchronous machine. The course also includes the modeling of excitation system, prime mover modeling and power system stability.

**Course Outcomes:**
After successful completion of the course, students will be able to:
1. Describe power system operating states and control
2. Analyze synchronous machine models
3. Model excitation and prime mover system
4. Describe the power system stability

**Prerequisite:**
Power system analysis, Power transmission and distribution, Computer methods in power systems analysis

**Course Content**

| Unit No. | Description | Hrs. |
|---|---|---|
| 1. | **Introduction to Modern Power Systems and Stability Problem**: Evolution of power system, Structure of a power system, power system control, control methods, operating states, control hierarchy, design and operating criteria for stability, Introduction to power system Security and contingency. | 06 |
| 2. | **Synchronous Machine Basics**: Elementary 3-phase machine, torque production, MMF distributed and concentrated windings, Mathematical Modeling of Synchronous Machine, Mutual and self-Inductances, Park's Transformation. | 06 |
| 3. | **Per Unit Representation of Synchronous Machine**: stator quantities, stator and rotor voltage equations, per unit stator and rotor flux linkage equations, per unit system for rotor, per unit power and torque, equivalent circuits for d-q axis. Synchronous machine under steady state. Transient characteristics of synchronous machine. | 06 |

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|---|---|---|
| **4.** | **Excitation system and Prime Mover Controllers**: Simplified Representation of Excitation Control, Excitation system, Modeling, standard. Block Diagram, Prime Mover Control System. | **06** |
| **5.** | **Power System Stability**: Basic concepts and definitions, Mid-term and long-term stability, frequency stability, Classification of stability, elementary view of transient stability, factors influencing transient stability, direct methods of transient stability analysis. | **06** |
| **6.** | **Voltage Stability**: Voltage stability, transmission system characteristics, generator characteristics, load characteristics, characteristics of reactive compensating devices, voltage collapse, typical scenario of voltage collapse, voltage stability analysis, prevention of voltage collapse. | **06** |

**References -**

**Text Books:**

- Prabha Kundur, Power System Stability and Control, Tata McGraw Hill

**References Books:**

- K. R. Padiyar, Power System Dynamics - Stability and Control, BS Publications
- R. Ramanujan, Power System Dynamics – Analysis and Simulation, PHI Learning Pvt. Ltd.
- A. Chakrabarti, Sunita Halder, Power system Analysis Operation and Control- PHI Learning Pvt. Ltd.

| Class: **F. Y. M. Tech. Elect. Power Systems & Power Electronics** | Semester-II |
|---|---|
| Course Code: **EPP2033** | Course Name: **Grid Integration of Renewable Energy Sources** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**

The generation of electricity from renewable energy sources includes technologies such as hydropower, wind power, solar power, tidal and wave power, geothermal power, and power from renewable biomass. Grid integration is an important aspect of renewable energy engineering and needs to be formally studied. This course includes study of distributed generation systems and to identify emerging issues with it, and thus understand the requirements for the correct integration of renewable energies into the power grid. Moreover, in this course it is also expected that the student will learn the power electronic components necessary for integration to include inverters and their control, island detection systems, and maximum power point tracking.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Summarize the grid codes for integration of renewable energy sources
2. Explain the working principle of different power electronic topologies and controllers.
3. Model mathematically renewable energy sources and associated control system
4. Design systems to reduce impact of renewable energy fluctuations on grid
5. Develop simulation systems using MATLAB

**Prerequisite:**

Power system, power semiconductor devices, electronic circuits, circuit theory.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Renewable Energy Services:** International requirements for large integration of renewable energy sources Ancillary services in RES, comparisons among different countries, Active power reserves and frequency control, Reactive power control/voltage control, RES under disturbances: fault ride-through capability, Renewable energy curtailment. | 06 |
| 2. | **Power Converter Topologies for Grid Interface of Wind Energy:** Variable speed operation and grid support requirements, power converters in doubly fed induction generator, control functions of different stages ratings of the power converters, protection during grid faults, power converters for type 4 wind generators, performance under grid faults, simulations | 06 |

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| **3.** | **Dynamic Models for Wind Generators:** Modeling of wind turbine generators for power flow analysis, modeling of wind turbine generators for transient, stability analysis, aerodynamic model, mechanical control and shaft dynamics, electrical generator characteristics, electrical control, generic model for type 3 wind turbine generators, wind farm representation | **06** |
| **4.** | **Control of Wind Generators :**Steady-state analysis of DFIG with per-phase equivalent circuit, development of per-phase equivalent circuit, speed-torque characteristics at different rotor voltages, steady-state analysis at various wind and rotor speeds, dynamic analysis of DFIG and design of controllers, torque or active power and reactive power references, grid voltage orientation references for rotor d- and q-axes currents, controller design for rotor current loops, control of the grid side converter , simulation | **06** |
| **5.** | **Maximum Power Point Tracking for Solar PV Systems:** solar photovoltaic cells, modules, and arrays, factors affecting PV output, tilt angles, partial shading, effect of light intensity, MPPT techniques, curve-fitting technique, fractional short-circuit current technique, fractional open-circuit voltage technique, look-up table technique, direct method, perturb and observe, incremental conductance method, simulations | **06** |
| **6.** | **Grid Integration of PV Systems:** Grid-connected PV power systems, inverter control algorithms, synchronous reference, frame–based current controller, digital PI-based current controller, adaptive notch filter-based grid, synchronization approach, modeling, simulation, and hardware implementation of controllers, PV system protection, faults in PV system, protection on the DC side, protection on the AC side, surge protection panel for PV inverter—AC side, simulations | **06** |

**References –**

**Text Books:**

- Antonio Moreno-Munoz, Large Scale Grid Integration of Renewable Energy Sources, The Institution of Engineering and Technology, London, United Kingdom

**Reference Books:**

- Majid Jamil, M. Rizwan, D. P. Kothari, Grid Integration of Solar Photovoltaic Systems, CRC Press Taylor & Francis Group
- Siegfried Heier, Grid integration of wind energy John Wiley & Sons, Ltd
- Vijay Vittal and Raja Ayyanar, Grid integration and dynamic impact of wind energy, Springer Science Business Media New York

| Class: **First Year M. Tech Power System & Power Electronics** | Semester- **II** |
|---|---|
| Course Code: **EPP2043** | Course Name: **Digital Protection of Power System** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | - | - | 3 |

**Course Description:** This course is a core course in F.Y. M. Tech program in semester II. In this course students will learn importance of power system protection with use of digital relays. This will extend the student to obtain mathematical background for developing different relay algorithms to fulfill requirement of today's smart grid. This course will focus on importance of maintaining safety in power station. It will provide a various application-oriented examples of design of protective system with proper selection of different equipment.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Discuss the importance of power electronics devices in power system protection.
2. Distinguish between conventional relays and modern relays
3. Apply mathematical approach towards protection
4. Develop algorithms for numerical protection
5. Explore recent advances in digital protection of power systems

**Prerequisite:**
Power system and power system protection, Mathematics, Digital electronics.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction of Power Electronics Devices in Protection**: Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection. | 04 |
| 2. | **Introduction to Computer Relaying**: Introduction, expected relay architecture, Basic elements of digital protection, Signal conditioning, Conversion subsystem, sources of error. | 06 |
| 3. | **Mathematical Background to Protection Algorithms**: Introduction Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm, Fourier and Walsh based algorithms. | 08 |
| 4. | **Numerical Relays**: Block diagram, flowchart and program for overcurrent relays, overvoltage relays, impedance relays, reactance relays and admittance relays. | 06 |

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| **5.** | **Traveling Wave based Technique**: Travelling waves in single phase and three phase lines, travelling waves due to faults, directional wave relay, Travelling wave distance relay. | **06** |
| **6.** | **Recent Advances in Digital Protection:** Introduction, Digital Differential Protection of Transformers, and Applications of advanced protective relaying. | **06** |

**References -**

**Text Books:**

- A.G. Phadke and J. S. Thorp, Computer Relaying for Power Systems, Wiley/Research studies Press
- Badri Ram and D.N. Vishwakarma, Power system Protection and Switchgear, Tata McGraw-Hill Education

**Reference Books:**

- A.T. Johns and S. K. Salman, Digital Protection of Power Systems, IEEE Press
- Gerhard Zeigler, Numerical Distance Protection, Siemens Publicis Corporate Publishing.
- S.R.Bhide Digital Power System Protection PHI Learning Pvt. Ltd.

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|---|---|
| Class: **First Year M. Tech Power System & Power Electronics** | Semester- **II** |
| Course Code: **EPP201** | Course Name: **High Power Converter Topologies and Control** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | - | - | 3 |

**Course Description:** High-power electronic converter topologies are crucial in various applications, particularly in areas like renewable energy, electric vehicles, industrial automation, and power grids. These converters play a significant role in efficiently converting electrical power from one form to another, enabling optimal performance, efficiency, and reliability in power systems. The significance of high-power electronic converter topologies lies in their ability to provide efficient, reliable, and cost-effective solutions for managing power in complex systems. They are fundamental to modern electrical engineering, particularly as we transition to more sustainable and technologically advanced energy systems.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Compare performance of power electronic switches for high power applications
2. Analyze the front-end active converters
3. Select the voltage source converter topology for high power applications
4. Apply isolated DC-DC converter and power factor correction converter for high end applications of power electronics
5. Design power electronic converter for power quality control and mitigation of harmonics

**Prerequisite:**
Power electronics, power quality, power system harmonics

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **High Power Semiconductor Devices:** Introduction, Diodes, Silicon Controlled Rectifiers (SCRs), Gate Turn-Off (GTO) Thyristor, Gate Commutated Thyristor (GCT), Insulated Gate Bipolar Transistor (IGBT), Other Switching Devices, Operation of Series Connected Devices, Main Causes of Voltage Unbalance, Voltage Equalization for GCTs, Voltage Equalization for IGBTs. | 04 |
| 2. | **Multi-pulse Rectifiers:** Six-Pulse Diode Rectifier, Series-Type Multi-pulse Diode Rectifiers: 12,18,24 pulse rectifiers, Separate-Type Multi-pulse Diode | 06 |

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|---|---|---|
| | Rectifiers: 12,18,24 pulse rectifiers,, Six-Pulse SCR Rectifier, 12-Pulse SCR Rectifier, 18- and 24-Pulse SCR Rectifiers. | |
| **3.** | **Multilevel Voltage Source Converters:** Two-Level Voltage Source Inverter, Cascaded H-Bridge Multilevel Inverters, Diode-Clamped Multilevel Inverters, Multilevel Flying-Capacitor Inverter, Space Vector PWM control of these converters. | **08** |
| **4.** | **Modular Multilevel Converters:** Converter Configuration, Configuration of Submodules, Comparison of Submodules, Principle of Operation, Pulse Width Modulation Schemes, Classical Control of Modular Multilevel Converter. | **06** |
| **5.** | **Isolated DC-DC Converters and Power Factor Correction Converter:** Isolated DC-DC Converters: Flyback, Forward, Cuk, SEPIC, Zeta, Half Bridge, Push-Pull and Bridge in DCM and CCM. Single-phase, Single-Stage Converters (SSSSC), Power Factor Correction at AC Mains in These Converters. Applications in SMPS, UPS, Welding, Lighting and EV Charging. | **06** |
| **6.** | **Power Quality Control using High Power Converter Topology:** Power Quality Monitoring, instrumentation and regulations. Static Series and Shunt Power Electronics Voltage Quality Controllers Modern Arrangement for Reduction of Voltage Fluctuation. Active Power Line Conditioner, Single-Phase Improved Power Quality AC-DC Converters: Buck, Boost, Buck-Boost, PWM VSC (Voltage Source Converters), Multilevel VSCs, PWM CSC (Current Voltage Source Converters) Three-Phase Improved Power Quality AC-DC converters: VSC, Multilevel VSCs, multi-pulse VSCs. | **06** |

**References -**

**Text Books:**

- M.H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson.
- Ned. Mohan, Power Electronics: Converters, Applications and Design, Wiley.
- J. R. Rodriguez, J. W. Dixon, J. R. Espinoza, J. Pontt and P. Lezana, PWM regenerative rectifiers: state of the art, in IEEE Transactions on Industrial Electronics

**Reference Books:**

- Bin Wu, High Power Converters and AC Drives, John Willey & sons, Inc.
- Sixing Du, Apparao Dekka, Bin Wu, and Navid Zargari, Modular Multilevel Converters: Analysis, Control, and Applications, John Wiley & Sons Ltd, IEEE press.
- P.C.Sen, Modern Power Electronics, S. Chand and Co. Ltd., New Delhi
- Kjeld Thorborg, Power Electronics In theory and Practice, Overseas Press

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|---|---|
| Class: **First Year M. Tech Power System & Power Electronics** | Semester-**II** |
| Course Code: **EPP2063** | Course Name: **Power System Restructuring** |

| L | T | P | Credits |
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**Course Description:**
This course is a Program elective offered to F.Y. M. Tech program in Semester II. The main goal of the course is to quickly review restructured power system and then discuss the existing information of Electric Power Markets. Emphasis is on different types of power markets, its structure, economics, and opportunities in electric power market, congestion management and ancillary services.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Describe the new dimensions associated with the power systems.
2. Determine transmission congestion management
3. Discuss pricing of transmission network
4. Explain ancillary service management in electrical market
5. Justify the role and functions of PX, IEX and various organization in Indian restructured power market

**Prerequisite:**
Computer methods in power systems analysis, power system management and optimization, Electricity ACT2003.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction to restructuring of power industry and economics:** Fundamentals of restructured system, market architecture, load elasticity, social welfare maximization. Reforms in Indian Power Sector | 06 |
| 2. | **Transmission Congestion Management:** Role in vertically integrated systems and in restructured markets, congestion management, Available Transfer Capability Evaluation and Methodologies. | 06 |
| 3. | **Pricing of transmission network:** Optimal bidding, risk assessment, hedging, Transmission Pricing Methods and Loss Allocation Algorithms, tracing of power, Marginal transmission pricing paradigm, Composite pricing paradigm. Locational Marginal Prices (LMP), Financial Transmission Rights (FTR) | 06 |
| 4. | **Ancillary Service Management:** Ancillary services, standard market design, distributed generation in restructured markets. | 06 |

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| **5.** | **Restructured Market scenario in India:** Developments in India, IT applications in restructured markets, Power Exchange (PX), Indian Energy Exchange, functions and responsibilities of various institutes. | **06** |
| **6.** | **Market Power:** Working of restructured power systems, PJM, recent trends in restructuring, exercise of market power. | **06** |

**References –**

**Text Book:**

- Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, Operation of restructured power systems, Kluwer Academic Pub.

**Reference Books:**

- Lorrin Philipson, H. Lee Willis, Understanding electric utilities and de-regulation, Marcel Dekker Pub
- Steven Stoft, Power system economics: designing markets for electricity, John Wiley and Sons
- Mohammad Shahidehpour, Muwaffaq Alomoush, Restructured electrical power systems: operation, trading and volatility, Marcel Dekker.

| | | | L | T | P | Credits |
|---|---|---|---|---|---|---|
| Class: **First Year M. Tech Power System & Power Electronics** | Semester-**II** | | 3 | -- | -- | 3 |
| Course Code: **EPP2073** | Course Name: **Power Quality and Harmonics** | | | | | |

**Course Description:** This course deals with the fundamentals and issues related to power quality and their mitigation techniques. It also deals with harmonic distortion and their mitigation.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Discuss various power quality problems and their analysis.
2. Classify various voltage quality issues and solutions.
3. Describe Power Quality Standards and Monitoring.
4. Asses sources of harmonic in power system
5. Analyze effects of Harmonics on Power system
6. Design of harmonic filters.

**Prerequisite:**
Power system, Electric Circuit Analysis and Mathematics.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Power Quality-** Power Quality Problems, power quality evaluation procedure, General Classes of Power Quality Problems, Transients Long-Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion, Voltage Fluctuation, Power Frequency Variations, Power Quality Terms, CBEMA and ITI Curves. Sources of Sags and Interruptions, Estimating Voltage Sag Performance, Fundamental Principles of Protection, Solutions at the End-User Level, Evaluating the Economics of Different Ride-Through Alternatives, Motor-Starting Sags, Utility System Fault-Clearing Issues. | 06 |
| 2. | **Transient Overvoltage's,-** Principles of Overvoltage Protection, Devices for Overvoltage Protection, Utility Capacitor-Switching Transients, Utility System Lightning Protection, Managing Ferro-resonance, Switching Transient Problems with Loads, Computer Tools for Transients Analysis, Principles of Regulating the Voltage, Devices for Voltage Regulation, Utility Voltage Regulator Application, Capacitors for Voltage Regulation, End-User Capacitor Application, Regulating Utility Voltage with Distributed Resources, Flicker. | 06 |

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| **3.** | **Power Quality Standards and Monitoring** -Purpose of Power Quality Standards, types of PQ standards, Trends in Power Quality Standards, PQ Monitoring Considerations, Historical Perspective of Power Quality Measuring Instruments, Power Quality Measurement Equipment, Assessment of Power Quality Measurement Data, Application of Intelligent Systems. | **06** |
| **4.** | **Harmonics:** The Mechanism of Harmonic Generation, Definitions and Standards, Harmonic Sources, Transformer Magnetisation Nonlinearities, Rotating Machine Harmonics, Distortion Caused by Arcing Devices, Single-Phase Rectification, Three-Phase Current-Source Conversion, Three-Phase Voltage-Source Conversion, Inverter-Fed A.C. Drives, Thyristor-Controlled Reactors, A.C. Regulators. | **06** |
| **5.** | **Effects of Harmonic Distortion**: Resonances, series, parallel, Complementary and Composite, Effects of Harmonics on Rotating Machines, Effect of Harmonics on Static Power Plant, Power Assessment with Distorted Waveforms, Harmonic Interference with Ripple Control Systems, 7 Harmonic Interference with Power System Protection, Effect of Harmonics on Consumer Equipment, Interference with Communications, Audible Noise from Electric Motors. | **06** |
| **6.** | **Harmonic Elimination**: Passive Filter Definitions, Filter Design Criteria, Network Impedance for Performance Calculations, Tuned Filters, Damped Filters, Conventional Filter Configurations, Band-Pass Filtering for Twelve-Pulse Converters, Distribution System Filter Planning, Filter Component Properties, D.C. Side Filters, Active Filters. | **06** |

**References -**

**Text Books:**

- R C Dugan, Electrical Power Systems Quality – Second Edition, McGraw-Hill
- Jos Arrillaga and Neville R. Watson, Power system harmonics, John Wiley & Sons

**Reference Books:**

- Francisco C. De La Rosa, Harmonics and Power Systems, CRC Press
- C. Sankaran, Power Quality, CRC press

| Class: **First Year M. Tech Power System & Power Electronics** | Semester- **II** |
|---|---|
| Course Code: **EPP2083** | Course Name: **Energy Storage Systems** |

| L | T | P | Credits |
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**Course Description:**

Storage is becoming an unavoidable part of the power system, to ensure security of supply and as a crucial form of flexibility. This course covers energy storage techniques involving electrochemical, mechanical and emerging options. Also, the course describes the advances in storage technology and its applications in the power system.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Discuss the energy storage as a structural unit of a power system.
2. Compare various energy storage technologies for power systems.
3. Apply battery energy storage and management for power system.
4. Describe hydrogen energy storage for power system.
5. Discuss short-term, mid-term and long-term applications of power system.
6. Analyze economics and reliability of energy storage Systems

**Prerequisite:**

Basic Electrical Engineering, General Science, Power Systems

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Energy Storage**: Introduction, Energy storage as a structural unit of a power system, General considerations, Definitions of Energy, power, Storage Form of Energy, Technical Definitions, Capacity, Depth of Discharge, State of Charge. "Round-Trip" Efficiency under Normal, Ideal, and Real Conditions, Charge and Discharge Losses Energy and power balance in a storage unit, Mathematical model of storage, Econometric model of storage, Characteristics of a storage system, Storage applications, Static duties of storage plant, Storage at the user's level. | 06 |
| 2. | **Energy Storage Technologies**: Pumped Hydroelectric Storage, Compressed Air Energy Storage, The Flywheel Energy Storage System, Supercapacitor Energy Storage System. | 06 |
| 3. | **Battery Energy Storage**: Introduction, different types of battery energy storage, Conventional Batteries and Flow Batteries, Basic Concepts, Lead–Acid Batteries, Nickel–Cadmium Batteries, Sodium–Sulfur Batteries, Lithium-Based Batteries, Flow Battery Energy Storage System, Battery | 06 |

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| | Management System (BMS), modeling of batteries, battery management systems, aging of batteries. | |
| **4.** | **Energy Storage Based on hydrogen:** Introduction, Structure of a storage system based on hydrogen, electrolysis of water, storage of hydrogen, conversion, efficiency considerations. | **06** |
| **5.** | **Short-Term Applications of ES**: Fluctuation Suppression, Low-Voltage Ride-Through (LVRT), Voltage Control Support, Oscillation Damping, Primary Frequency Control, An Example of Fluctuation Suppression, Mid- and Long-Term Applications, Load Following, Peak Shaving, Transmission Curtailment, Time Shifting, Unit Commitment, Seasonal Storage. | **06** |
| **6.** | **Economics and Reliability of Electric Energy Storage Systems**: Electric-Energy Storage Economics, cost analysis, Investment and Operation Costs Analysis of EES, Reliability in Power-Energy Systems, Grid-Reliability Calculations, Storage-System Reliability. | **06** |

**References –**

**Text Books:**


- A. Ter-Gazarian, Energy Storage for Power Systems, Peter Peregrinus Ltd. London
- Francisco Diaz-Gonazalez, Andreas Sumper "Energy Storage in Power Systems" Wiley
- Alfred Rufer, Energy Storage Systems and Components, CRC Press


**Reference Books:**


- Przemyslaw Komarnicki, Pio Lombardi, Zbigniew Styczynsk , Electric Energy Storage Systems Flexibility Options for Smart Grids
- Frank S. Barnes & Jonah G. Levine, Large Energy storage Systems Handbook, CRC Press

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|---|---|
| Class: **First Year M. Tech Power System & Power Electronics** | Semester- **II** |
| Course Code: **EPP202** | Course Name: **Machine Learning Applications in Power Engineering** |

| L | T | P | Credits |
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**Course Description:** This course is offered as a program elective course based on current edge technologies. The course introduces the fundamental concepts of machine learning, covering supervised, unsupervised, and reinforced learning techniques. Students will gain knowledge on machine learning software to solve practical problems and apply algorithms to Electrical Engineering challenges, particularly in electric power systems. The course also focuses on identifying and addressing key challenges in deploying machine learning solutions in this domain, equipping students with the skills to innovate and tackle real-world engineering problems.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Discuss the basic concepts of machine learning techniques
2. Distinguish between supervised learning, unsupervised learning and reinforced learning
3. Develop the skills using machine learning software for solving practical problems
4. Apply machine learning algorithms for Electrical Engineering problems
5. Identify the challenges for successful deployment of machine learning in electric power systems.

**Prerequisite:**

Power Systems, Power electronics, Programming.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction of Machine Learning**: Introduction to Machine learning; neural networks, models of neuron network; Architectures – Knowledge representation, Artificial intelligence and neural network – learning process, error correction learning, multi later perception using Back Propagation Algorithm (BPA). | 06 |
| 2. | **Learning Theory**: What is Learning, Learning Objectives, data needed, Bayesian inference and Learning, Bayes theorem, inference, naive Bayes, Regularization, Bias-Variance Decomposition and Trade-off, Concentration Inequalities, Generalization and Uniform Convergence, VC-dimension; Types | 06 |

| | | |
|---|---|---|
| | of Learning- Supervised Learning - Unsupervised Learning and Reinforcement Learning. | |
| 3. | **Supervised Learning**: Simple near Regression, Multiple Linear Regression- Logistic Regression, Exponential Family and Generalized Linear Models- Generative Models: Gaussian Discriminate Analysis, Naive Bayes, Kernal Method: Support Vector Machine (SVM) - Kernal function - Kernal SVM - Gaussian Process, Tree Ensembles: Decision Trees, Random Forests - Boosting and Gradient Boosting. | 06 |
| 4. | **Unsupervised Learning (Clustering)**: K-means Clustering Algorithm, Gaussian Mixture Model (GMM), Expectation Maximization (EM) Variational Auto Encoder (VAE), Factor Analysis, Principle Components Analysis (PCA), Independent Component Analysis (ICA). | 06 |
| 5. | **Reinforcement Learning**: Markov Decision Processes (MDP), Bellman's Equations, Value Iteration and Policy Iteration, Value Function Approximation, Q - Learning | 06 |
| 6. | **Applications of ML:** Load Forecasting, Energy Market forecasting, Fault identification and localization, Renewable energy forecasting, Fault identification and localization, Renewable Uncertainty estimation. ML for solar power MPPT, False data injection attack detection, and Control of Power Converters. | 06 |

**References -**

**Text Books:**

- Christopher Bishop, Pattern Recognition and Machine Learning, Springer
- E. Alpaydin, Machine Learning, MIT Press
- Anuradha Srinivasaraghavan, Vincy Joseph, Machine Learning, Wiley

**Reference Books:**

- Giuseppe Bonaccorso, Machine Learning Algorithms, Packt Publishing
- Tom M Mitchell, Machine Learning, McGraw Hill International

| Class: **First Year M. Tech Power System & Power Electronics** | Semester-**II** |
|---|---|
| Course Code: **EPP2093** | Course Name: **Research Methodology & IPR** |

| L | T | P | Credits |
|---|---|---|---|
| 2 | 1 | -- | 3 |

**Course Description:**

This course is a mandatory course in FY M. Tech program in Semester II. The course introduces students to educational research methods. The aim of the course is to offer students the tools to conceptualize their Master's theses in terms of research methodology, data collection, statistical analysis, report writing and publications. The course is designed to provide prospective researchers with a broad introduction to statistical tools with software.

**Course Outcomes:**

At the end of this course students will be able to,

1. Formulate a research problem.
2. Analyze literature study and research related information
3. Prepare and present research proposal/paper by following research ethics
4. Make effective use of computers and computing tools to search information, analyze information and prepare report.
5. Describe nature and processes involved in development of intellectual property rights

**Prerequisite:**

English, Computer tools, Programming, Statistics.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Meaning of research problem**: Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem | 04 |
| 2. | **Effective literature study approaches**: Plagiarism, Research ethics, Approaches of investigation of solutions for research problem, data collection, Data analysis with software, interpretation, Necessary instrumentations | 04 |
| 3. | **Hypothesis:** Construction, functions, types of hypotheses, errors in testing of hypothesis. | 04 |
| 4. | **Effective technical writing**: how to write technical report and paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. | 04 |
| 5. | **Nature of Intellectual Property**: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property, Procedure for grants of patents, Patenting under PCT. | 04 |

| | | |
|---|---|---|
| **6.** | **Developments in IPR**: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications. Administration of Patent System, New developments in IPR; IPR of Biological Systems, Computer Software etc., Traditional knowledge Case Studies, IPR and IITs. | **04** |

**References -**

**Text Books:**

- Ranjit Kumar, Research Methodology: A Step-by-Step Guide for beginners, SAGE Publication
- C. R. Kothari, Research Methodology: Methods & Techniques. Wishwa Prakashan

**Reference Books:**

- Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students, Juta & Co Ltd
- Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Juta Academic
- Halbert, Resisting Intellectual Property, Taylor & Francis Ltd
- Mayall, Industrial Design, McGraw Hill
- Niebel, Product Design, McGraw Hill
- Asimov, Introduction to Design, Prentice Hall
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age, Wolters Kluwar
- T. Ramappa, Intellectual Property Rights Under WTO, S. Chand

| Class: **First Year M. Tech Power System & Power Electronics** | Semester-**II** |
|---|---|
| Course Code: **EPP2103** | Course Name: **Advanced Power System Protection Lab** |

| L | T | P | Credits |
|---|---|---|---|
| - | - | 2 | 1 |

**Course Description:**
This laboratory course will provide a platform to demonstrate the performance of protection panels. It will focus on analyzing the characteristics of microprocessor-based relays. Transmission line simulation unit is helpful in finding out not only the fault location but also checks the performance of impedance relays. Finally, this course also includes the simulations and algorithms.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Analyze characteristics of digital relays
2. Demonstrate fault simulation on different protection panels
3. Develop an algorithm for different protection schemes
4. Simulate protection models
5. Interpret the simulation results

**Prerequisite:**
Power system, power system protection, Mathematics

List of Experiments:

| Expt. No | Description | Duration (hours) |
|---|---|---|
| 1. | To visit 11kV/ 400V switchyard for understanding functions of different protective devices | 2 |
| 2. | To calculate dielectric strength of solid and liquid insulating materials. | 2 |
| 3. | To analyze characteristics of microprocessor-based relays (Normal inverse, IDMT, very inverse) | 2 |
| 4. | To analyze characteristics of microprocessor-based relays (Definite time, extreme inverse) | 2 |
| 5. | To simulate and analyze different symmetrical and unsymmetrical faults on three phase Transformer | 2 |
| 6. | To simulate and analyze different faults and abnormalities on three phase alternators | 2 |
| 7. | To simulate and analyze distance protection schemes on Transmission line | 2 |
| 8. | To design protection schemes | 2 |

| | | |
|---|---|---|
| **9.** | To simulate and analyze faults on power system software package1. | 2 |
| **10.** | To simulate and analyze faults on power system software package2. | 2 |
| **11.** | To perform advanced protective relay 1 on microprocessor kit | 2 |
| **12.** | To perform advanced protective relay 2 on microprocessor kit | 2 |

**References:**

- Laboratory Manual
- Demo models and simulations

| | |
|---|---|
| Class: **First Year M. Tech Power System & Power Electronics** | Semester- **II** |
| Course Code: **EPP2113** | Course Name: **Advanced Electric Drives Lab** |

| L | T | P | Credits |
|---|---|---|---|
| - | - | 2 | 1 |

**Course Description:**

This course deals with different kinds of electrical machine-drives and required subsystems. Learner will perform the experiments on different electrical machines fed through power electronic converters. Sketch the speed torque characteristics, measure the performance for different machines fed through different types of power electronic converters.

**Course Outcomes:**

**After successful completion of the course, students will be able to,**

1. Demonstrate control of Induction motor drive.
2. Experiment with chopper fed DC drive system.
3. Experiment with three phase half and full converter fed DC motor drive.
4. Demonstrate control of BLDC, servo and stepper motor drive system.
5. Demonstrate control of AC and DC drives using MATLAB/SIMULINK

| Expt. No | Description<br>Study and analysis of | Duration (Hours) |
|---|---|---|
| 1. | Vector Control of three phase induction motor. | 2 |
| 2. | V/ F Control of three phase induction motor with simulation | 2 |
| 3. | Study of Speed-torque characteristics of separately excited DC motor using chopper. | 2 |
| 4. | Study of Speed-torque characteristics of DC Shunt motor from three phase half-controlled converter. | 2 |
| 5. | Study of Speed-torque characteristics of separately excited DC motor from three phase full controlled converter. | 2 |
| 6. | Three phase induction motor speed control using slip power recovery scheme. | 2 |
| 7. | Study of speed control for BLDC drive. | 2 |
| 8. | Study of Speed-torque characteristics of BLDC motor drive. | 2 |
| 9. | Study of control for servo motors. | 2 |
| 10. | Study of control for stepper motors. | 2 |

| | | |
|---|---|---|
| 11. | Simulation of chopper fed DC motor drive using software. | 2 |
| 12. | Simulation of Single-phase converter fed DC motor drive using software. | 2 |
| 13. | Simulation of variable frequency control for induction motor drive using software. | 2 |
| 14. | Simulation of Inverter fed Induction motor drive using software. | 2 |

**References -**

**Text Books:**

- P.C. Sen, Principles of Electric Machines and Power Electronics, Third Edition, Wiley
- Bimal K Bose, Modern Power Electronics and AC Drives, Pearson Education

**Reference Books:**

- Electric Motor Drives: Modeling, Analysis, and Control, Prentice Hall publications
- Gopal K Dubey, Fundamentals of the electrical drives, Narosa publication
- Vedam Subrahnyam, Electrical Drives Concept and application, Tata McGraw Hill publication

| Class: **First Year M. Tech Power System & Power Electronics** | Semester- **II** |
|---|---|
| Course Code: **EPP121** | Course Name: **Seminar** |

| L | T | P | Credits |
|---|---|---|---|
| -- | -- | 2 | 1 |

**Course Description:**

This course is designed to help students to enhance the research, analytical, and presentation skills. Students will independently explore contemporary topics, emerging technologies, or advanced research areas in their field of study. Students are expected to do extensive literature review and critical analysis required for their dissertation work. Students will develop the ability to effectively communicate technical content, engage in scholarly discussions, and address complex engineering challenges. This course fosters self-directed learning, collaboration, and professional development, preparing students for research and industry-oriented roles in power systems and power electronics.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Acquire in-depth knowledge of selected seminar topic area
2. Carry out the literature review of selected research topic
3. Demonstrate the ability to describe, interpret and analyze the subject matter and develop competence in presenting
4. Prepare a well-organized report employing elements of critical thinking and technical writing

**Guidelines:**

1. Student has to present a seminar, on a topic selected in consultation with assigned Faculty member, in the allotted seminar slot as per academic calendar.
2. Seminar topic should be based on recent research articles or industry case study useful for dissertation work.
3. Seminar will be examined by the faculties as per the rubrics. ISE (100%) marks will be given by a panel of members allotted by DPC to the students based on their presentations and demonstration of the project work

**References -**

- Journal and conference papers from reputed publishers such as IEEE, Elsevier, and Wiley etc.
- Research Articles / Reports available in the library and on internet.

| Class: **Second Year M. Tech Power System & Power Electronics** | Semester- **III** |
|---|---|
| Course Code: **EPP3013** | Course Name: **Industry Internship** |

| L | T | P | Credits |
|---|---|---|---|
| -- | -- | -- | 1 |

**Course Description:**

This course provides a practical exposure to students. In this student is expected to get training in the industry, related to subject specialization. This course also provides platform to solve real time problem associated with electrical engineering domain

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Apply engineering knowledge learned during the program.
2. Apply his/her technical skills to solve industrial problem.
3. Work in multi-disciplinary environment.

**General Guidelines:**

1. In the industry internship / field training work, student is expected to get training in the industry, related to subject specialization for duration of 15 days (minimum) for at least 6 hours per day.
2. Student should complete industry training and get certificate. The certificate copy should be submitted to head of program with supervisor signature.
3. For the completed industrial training student should write a report and submit the same for evaluation.

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| Class: **S. Y. M. Tech** | Semester- **III** |
|---|---|
| Course Code: **MOE2012** | Course Name: **Artificial Intelligence and Machine Learning** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | | -- | 3 |

**Course Description:**
Machine learning is a part of Artificial Intelligence. It uses interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention. Machine learning as a field is now incredibly pervasive, with applications spanning from business intelligence to homeland security, from analyzing biochemical interactions to structural monitoring of aging bridges, and from emissions to astrophysics, etc. This class will familiarize students with a broad cross-section of models and algorithms for machine learning, and prepare students for research or industry application of machine learning techniques.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Describe central machine learning methods and techniques and how they relate to artificial intelligence
2. Differentiate between supervised and unsupervised learning techniques
3. Apply the ML algorithms to a real-world problem,
4. Optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
5. Evaluate a given problem and apply appropriate machine learning technique

**Prerequisite:**
Statistics, linear algebra, optimization techniques, programming language

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction to Artificial Intelligence and Machine learning:** Introduction: What Is AI and ML? Examples of AI and ML, Applications, Supervised Learning, Un-Supervised Learning and Reinforcement Learning, Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches, Elements of information theory | 06 |

| | | |
|---|---|---|
| 2. | **Feature Selection:** Scikit- Learn Dataset, Creating training and test sets, managing categorical data, Managing missing features, Data scaling and normalization, Feature selection and Filtering, Principle Component Analysis (PCA)- non-negative matrix factorization, Sparse PCA, Kernel PCA. Atom Extraction and Dictionary Learning. | 06 |
| 3. | **Regression:** Linear regression- Linear models, A bi-dimensional example, Linear Regression and higher dimensionality, Polynomial regression, Logistic Regression-Linear classification, Logistic regression, Implementation and Optimizations, Stochastic gradient descendent algorithms | 06 |
| 4. | **Naïve Bayes and Support Vector Machine:** Bayes Theorem, Naïve Bayes Classifiers, Naïve Bayes in Scikit- learn- Bernoulli Naïve Bayes, Multinomial Naïve Bayes, and Gaussian Naïve Bayes.<br>**Support Vector Machine (SVM)-** Linear Support Vector Machines, Scikit- learn<br>Implementation, Linear Classification, Kernel based classification, Non- linear Examples. Controlled Support Vector Machines, Support Vector Regression. | 06 |
| 5. | **Decision Trees and Ensemble Learning:** Decision Trees- Impurity measures, Feature Importance. Decision Tree Classification with Scikit learn, Ensemble Learning-Random Forest, AdaBoost, Gradient Tree Boosting, Voting Classifier. Clustering Fundamentals- Basics, K-means: Finding optimal number of clusters, DBSCAN, Spectral Clustering. Evaluation methods based on Ground Truth- Homogeneity, Completeness, Adjusted Rand Index. | 04 |
| 6. | **Clustering Techniques:** Hierarchical Clustering, Expectation maximization clustering, Agglomerative Clustering Dendrograms, Agglomerative clustering in Scikit- learn, Connectivity Constraints.<br>Introduction to Recommendation Systems- Naïve User based systems, Content based Systems, Model free collaborative filtering-singular value decomposition, alternating least squares. | 08 |

**References –**

**Text Books:**

- Giuseppe Bonaccorso, Machine Learning Algorithms, Packt Publishing Limited.
- Josh Patterson, Adam Gibson, Deep Learning: A Practitioners Approach, O"REILLY, SPD publication

**Reference Books:**

- Ethem Alpaydin, Introduction to Machine Learning, PHI publication.
- Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press publication

| Class: **S. Y. M. Tech** | Semester-**III** |
|---|---|
| Course Code: **MOE2022** | Course Name: **Creative Thinking: Techniques and Tools** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | -- | -- | 3 |

**Course Description:**

In today's ever-growing and changing world, being able to think creatively and innovatively are essential skills. It can sometimes be challenging to step back and reflect in an environment which is fast paced or when students required to assimilate large amounts of information. Making sense of or communicating new ideas in an innovative and engaging way, approaching problems from fresh angles, and producing novel solutions are all traits which are highly sought after by employers. This course will equip with a 'tool-box', introducing to a selection of behaviours and techniques that will augment innate creativity. Some of the tools are suited to use on own and others work well for a group, enabling you to leverage the power of several minds. People can pick and choose which of these tools or techniques suit needs and interests, focusing on some or all of the selected approaches and in the order that fits best.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Comprehend importance in tackling global challenges as well as in everyday problem-solving scenarios.
2. Apply different brainstorming techniques in group activities.
3. Be proficient in the application of the 6 thinking hats tool in different life scenarios.
4. Develop a systematic approach to idea generation through the use of morphological analysis.
5. Innovate on an existing product, service or situation applying the SCAMPER method.
6. Get confident with the theory of inventive problem solving, called TRIZ.

**Prerequisite:**

There are no prerequisites to this course.

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1. | **Introduction to the Principles of Creativity:** Basic principles of creativity and highlight its importance in tackling global challenges. Creativity is explored and applied at two different levels, lower and higher-level creativity | 06 |
| 2. | **Creativity Tools:** Augment our creativity using different methods of Brainstorming, a creativity approach that aids the generation of ideas in solving a stated problem. Particularly focus on the application of brainstorming tools in group activities, with the aim of enabling to understand, evaluate and apply different types of brainstorming techniques in own context. | 06 |

| | | |
|---|---|---|
| 3. | **Six Thinking Hats:** Principles as well as application of the 6 Hats thinking tool both at an individual level and in a group, under various professional and personal situations, allowing students to develop competency and accelerate proficiency on the use of technique. | 06 |
| 4. | **Clarifying the Problem:** Organizing a process, turning problems into opportunities, facts, feelings & hunches, problem as question. | 06 |
| 5. | **Generating Ideas:** Brainstorming, scamper, forced connections, portable think tank, case studies on generating ideas. | 06 |
| 6. | **Developing Ideas & Planning for action:** Organizing ideas, ideas to solutions, implementing solutions, case studies of development of ideas and plan of action. | 06 |

**References –**

**Text Books:**

- Michael Michalko, Thinker toys: A Handbook of Creative-Thinking Techniques, Ten Speed Press.
- Michael Michalko, Cracking Creativity: The Secrets of Creative Genius. Ten Speed Press.
- Edward de Bono, Lateral Thinking: A Textbook of Creativity, Penguin.
- Edward de Bono, Six Thinking Hats, Penguin.

**Reference Books:**

- Creative Thinkering: Putting Your Imagination to Work, New World Library.
- Chris Griffiths, Kogan. The Creative Thinking Handbook: You're Step by Step Guide to Problem Solving in Business.

| Class: **S. Y. M. Tech** | Semester-III | L | T | P | Credits |
|---|---|---|---|---|---|
| Course Code: **MOE2032** | Course Name: **MOOC Course** | 3 | - | - | 3 |

**Course Description:**

Student can opt for online certification course and produce certificate.

- The students who are doing course on MOOC/NPTEL Course /Courses suggested by DPGC should select the course in consultation with supervisor and submit the details to Head of Program.
- The course should be minimum 25 hours duration and should have certification facility.
- Student should complete course and get certificate. The certificate copy should be submitted to head of program with supervisor signature.

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Identify the real applications and practices of courses studied, at industry level
2. Recognize various modeling, analysis and validation techniques adopted at industries.
3. Demonstrate the issues at design, manufacturing and assembly levels.
4. Summarize and present technical data in report format.

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| Class: **S. Y. M. Tech** | Semester: **III** | L | T | P | Credits |
|---|---|---|---|---|---|
| Course Code: **MOE2041** | Course Name: **Energy Audit and Management** | **03** | **--** | **--** | **03** |

**Course Description:**
This course provides basic understanding of energy audit and management. Essential theoretical and practical knowledge about the concept of energy conservation, energy management, and different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit and measuring instruments in commercial and industrial sector will be achieved through this course.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Identify the important of Energy Scenario.
2. Use energy audit knowledge to carry out energy audit of a given firm.
3. Examine different rolls in energy action planning
4. Apply project finance and management skills to carry out energy audit
5. Plan for energy monitoring and targeting.

**Prerequisite:**
Electric Machines, Thermal Systems and Finance system

| Course Content | | |
|---|---|---|
| **Unit No** | **Description** | **Hrs.** |
| **01** | **Energy Scenario:** Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment, Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features. | **06** |
| **02** | **Energy Management and Audit:** Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments | **06** |
| **03** | **Energy Action Planning:** Key elements, Force field analysis, Energy policy purpose, perspective, Contents, Formulation, Ratification, Organizing – location of energy management, Top management support, Managerial function, Roles and responsibilities of energy manager, Accountability. | **06** |

| | | |
|---|---|---|
| | Motivating-motivation of employees: Information system-designing barriers, Strategies; Marketing and communicating-training and planning. | |
| **04** | **Financial Management:** Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs | **06** |
| **05** | **Project Management:** Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification | **06** |
| **06** | **Energy Monitoring and Targeting:** Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques -energy consumption, Production, Cumulative sum of differences (CUSUM). | **06** |

**References –**

**Text Books:**


- Amit Kumar Tyagi, Handbook on Energy Audits and Management, TERI Publication
- Wayne C. Turner, Energy Management Handbook, Wiley Inter Science Publication


**Reference Books:**


- P. O'Callaghan, Energy Management, McGraw - Hill Book Company
- Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I


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| Class: **S. Y. M. Tech** | Semester – **III** |
|---|---|
| Course Code: **MOE2062** | Course Name: **Augmented Reality and Virtual Reality** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | - | - | 3 |

**Course Description:**
This course presents an introduction to virtual and augmented reality technologies, with an emphasis on designing and developing interactive virtual and augmented reality experiences. The course will cover the history of the area, fundamental theory, and interaction techniques. Students are provided with hands-on experience developing applications for modern virtual and augmented reality systems. In the course, students will also explore libraries and tools for creating AR/VR experiences such as Vuforia and UNITY.

**Course Outcomes:**
After successful completion of the course, students will be able to:
1. Define the basic concepts of Virtual and Augmented Reality
2. Identify the differences in AR/VR concepts and technologies
3. Describe the fundamental concepts relating to Virtual Reality such as presence, immersion, and engagement
4. Evaluate usability of AR/VR applications and critique their use of AR/VR capabilities
5. Design and prototype effective AR/VR applications using UNITY platform for various application.

**Prerequisites:**
Programming and Data Structures

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1 | **Introduction to Augmented Reality:** Definition and Scope, Brief History of Augmented Reality, Displays (Multimodal Displays, Spatial Display Model, and Visual Displays), Strong vs Weak, AR Applications AR Challenges in AR. | 06 |
| 2 | **Introduction to Virtual Reality:** Definition and Scope, Types of VR Characteristics, Basic VR environments, Limitations of VR environments, Immersion Vs Presence. | 06 |
| 3 | **Interaction design for AR/VR environments:** Interaction design process Identifying user needs, AR/VR design considerations. Typical AR/VR Interface Metaphors, User experience (UX) guidelines for AR/VR, UX challenges for AR/VR, Prototyping for AR/VR, Evaluation of the developed AR/VR prototype. | 06 |

| | | |
|---|---|---|
| 4 | **Introduction to UNITY:** Unity Overview: Windows, Interface, Navigation, Terminology, Game Objects, Hierarchy, Parenting Objects, Asset Store, Importing Plug-ins, Creating a Terrain, Materials, Colors, Transparency, Introduction to Mono behaviors: Awake, Start, Update. | 06 |
| 5 | **Introduction to Vuforia and Physics in UNITY:** Vuforia Overview: Interface, Navigation, Terminology, Image Targeting, Custom Images, Overview of Physics in Unity, Introduction to Scripting: Terminology, Creating Objects, Accessing Components, Debugging, Lists, Loops. | 06 |
| 6 | **Expanding on Scripting and Interaction:** Creating Trigger Events, Manipulating Components in Scripts, Programming Interactions between Objects and Tracked Images in AR, designing a simple User Interface in AR, Introduction to colliders and their use: On Collision Enter, On Collision Exit. On Collision Stay, On Trigger vs On Collision, Rigid bodies and how Colliders report to them. | 06 |

**References -**

**Text Books:**


- Vince, Virtual Reality Systems, Pearson Education.
- Grigore Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley.
- Schmalstieg, D., & Hollerer, T. *Augmented reality: principles and practice.*Addison-Wesley Professional.


**Reference Books:**


- Azuma, R.T., A survey of augmented reality. Presence: Teleoperators & Virtual Environments, 6(4), 355–385.
- Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. Recent advances in augmented reality. IEEE computer graphics and applications, 21(6), 34-47.
- Bhagat, K. K., Liou, W.-K., & Chang, C.-Y. A cost-effective interactive 3D virtual reality system applied to military live firing training. Virtual Reality, 20(2), 127-140. doi:10.1007/s10055-016-0284-x
- Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E., & Ivkovic, M. Augmented reality technologies, systems and applications. Multimedia tools and applications, 51(1), 341-377.
- Raisamo, R., Rakkolainen, I., Majaranta, P., Salminen, K., Rantala, J., & Farooq, A. Human augmentation: Past, present and future. International journal of human- computer studies, 131, 131-143. doi: https://doi.org/10.1016/j.ijhcs.2019.05.008
- Schuemie, M. J., Van Der Straaten, P., Krijn, M., & Van Der Mast, C. A. Research on presence in virtual reality: A survey. CyberPsychology & Behavior, 4(2), 183-201.

| Class: **S. Y. M. Tech** | Semester-**III** |
|---|---|
| Course Code: **MOE2072** | Course Name: **Industrial Instrumentation** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | - | -- | 3 |

**Course Description:**
This course is an overview of the principles, concepts, and applications of process transmitters found in an industrial plant. Continuous measurement and control of all the parameters will be emphasized. Also, practical installation and calibration procedures of various types of sensors and transducers will be covered. Open and closed loop control systems will also be discussed, including such concepts as on/off control, setpoint, overshoot, undershoot, gain, feedback, PID loops, and reverse/direct acting systems.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Elaborate working principal of different transducers.
2. Select suitable transducer/sensor for specific application.
3. Justify the use of specific measurement technique for specific task.
4. Evaluate the Calibration and Interfacing of the transducers.

**Prerequisite:**
Physics

**Course Content**

| Unit No | Description | Hrs. |
|---|---|---|
| 1 | **Metrology:** Measurement of length – Gauge blocks – Plainness – Area using Simpson's rule, Plain meter – Diameter – Roughness – Angle using Bevel protractor, sine bars and Clinometer – Mechanical, Electrical, Optical and Pneumatic Comparators. Optical Methods for length and distance measurements using Optical flats and Michelson Interferometer. | 06 |
| 2 | **Velocity and Acceleration Measurement:** Relative velocity – Translational and Rotational velocity measurements – Revolution counters and Timers – Magnetic and Photoelectric pulse counting stroboscopic methods. Accelerometers-different types, Gyroscopes-applications. | 06 |
| 3 | **Force and Pressure Measurement:** Force measurement – Different methods –Gyroscopic Force Measurement – Vibrating wire Force transducer. Basics of Pressure measurement –Manometer types – Force-Balance and Vibrating Cylinder Transducers – High- and Low-Pressure measurement – McLeod Gauge, Knudsen Gauge, Momentum Transfer Gauge, Thermal Conductivity Gauge, Ionization Gauge, Dual Gauge Techniques, Deadweight Gauges, Hydrostatic Pressure Measurement | 06 |
| 4 | **Flow Measurement and Level Measurement:** Flow Meters- Head type, Area type (Rota meter), electromagnetic type, Positive displacement type, mass flow meter, ultrasonic type, vertex shedding type, Hotwire anemometer type, Laser Doppler Velocity-meter. Basic Level | 06 |

| | | |
|---|---|---|
| | measurements – Direct, Indirect, Pressure, Buoyancy, Weight, Capacitive Probe methods. | |
| 5 | **Density, Viscosity and Other Measurements:** Density measurements – Strain Gauge load cell method – Buoyancy method – Air pressure balance method – Gamma ray method – Vibrating probe method. Units of Viscosity, specific gravity scales used in Petroleum Industries, Different Methods of measuring consistency and Viscosity –Two float viscorator – Industrial consistency meter. Sound-Level Meters, Microphones, Humidity Measurement. | **06** |
| 6 | **Calibration and Interfacing:** Calibration using Master Sensors, Interfacing of Force, Pressure, Velocity, Acceleration, Flow, Density and Viscosity Sensors, Variable Frequency Drive.<br>Open and closed loop control system with on/off control, setpoint, overshoot, undershoot, gain, feedback, PID loops, and reverse/direct acting systems. | **06** |

**References -**

**Text Books:**


- Doeblin E.O., Measurement Systems – Applications and Design, McGraw Hill International
- Patranabis D, Principles of Industrial Instrumentation, Tata McGraw Hill


**Reference Books:**


- Considine D. M., Process Instruments and Control Handbook, McGraw Hill International
- Jain R.K., Mechanical and Industrial Measurements, Khanna Publications

| Class: **S. Y. M. Tech** | Semester - **III** |
|---|---|
| Course Code: **MOE2082** | Course Name: **Advanced Mechatronics Systems** |

| L | T | P | Credits |
|---|---|---|---|
| 3 | - | - | 3 |

**Course Description:**
The course will be helpful to provide overview of mechanical and electronic systems used in industrial atmosphere. This will be helpful for upcoming automation in industry. Mechatronics is a multidisciplinary field of science that includes a combination of Mechanical Engineering, Electronics, Computer Engineering, Telecommunications Engineering and Control Engineering. Mechatronics is a multi-disciplinary study dealing with the integration of mechanical devices, actuators, sensors, electronics, intelligent controllers and computers. Mechatronics generally involves

(i) implementing electronics control in a mechanical system
(ii) enhancing existing mechanical design with intelligent control and
(iii) replacing mechanical component with an electronic solution.

This course will cover all aspects related with mechatronics such as sensors and transducers, actuators and mechanisms, signal conditioning, microprocessors and microcontrollers, modeling & system response and design of mechatronics systems.

**Course Outcomes:**
After successful completion of the course, students will be able to,
1. Explain Mechatronics System
2. Analyze the Mechatronics Based System
3. Model, simulate, and verify the mechatronics systems.
4. Identify Electrical, Hydraulic and Pneumatic Components.

**Prerequisite:**
Basic knowledge of research related activities.

**Course Content**

| Unit No. | Description | Hrs. |
|---|---|---|
| 01 | **Introduction:** What is Mechatronics, Integrated Design Issues in mechatronics, Mechatronics Design Process, Mechatronics Key elements, applications in mechatronics. | 06 |
| 02 | **Modelling and Analysis of Mechatronics Systems:** Block Diagram Modelling, Analogy approach, Impedance Diagrams, Electrical Systems, Mechanical systems and electromechanical systems. Mass-Spring-Oscillation and Damping system, Dynamic response of systems, Transfer function and frequency response. Labview, MATLAB, Scilab. | 06 |

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|---|---|---|
| 03 | **Sensors and Actuators:** Performance terminology of sensors, Displacement, Position & Proximity Sensors, Displacement, Position sensors, Force, Fluid pressure, Liquid flow sensors, temperature, light sensor, Acceleration and Vibration measurement, Electrical and Mechanical Actuation Systems. | 06 |
| 04 | **Signal Conditioning:** Introduction to signal processing, Op-Amp as signal conditioner, Analogue to Digital Converter, Digital to Analogue Converter, Signal processing devices, relays, contactors and timers. Microcontrollers, PID controllers and PLCs. | 06 |
| 05 | **Hydraulic system and Pneumatic system:** Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps, Pneumatic system components and graphic representations, Advantages and limitations of pneumatic systems. | 06 |
| 06 | **Case Study:** List of various mechatronics systems, Case study of pick and place mechanism of robotic arm using pneumatic power, Hydraulic circuit for CNC Lathe machine, 3D Printer, Auto-control system for Green House Temperature and Auto-focusing in Digital Cameras. | 06 |

**References –**

**Text Books:**

- Bradley, D. Dawson, N.C.Burd and A.J. Loader, Mechatronics: Electronics in product and process, Chapman and Hall, London.
- Devadas Shetty, Richard A.Kolkm, Mechatronics system design, PWS publishing company.
- David G. Alciatore, Michael B. Histand, Introduction to mechatronics and measurement systems, Mc Graw Hill Education.

**References Books:**

- Intelligent Mechatronic Systems: Modeling, Control and Diagnosis, R. Merzouki, A. K. Samantaray, P. M. Pathak, B. Ould Bouamama, Springer, London.
- Technical website: https://onlinecourses.nptel.ac.in/noc21_me27/course

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| Class: **S. Y. M. Tech** | Semester: **III** |
|---|---|
| Course Code: **MOE2091** | Course Name: **Disaster Management** |

| L | T | P | Credits |
|---|---|---|---|
| 03 | -- | -- | 03 |

**Course Description:**
This course provides a holistic understanding of disaster management, covering both natural and manmade disasters. Students will delve into the meaning, nature, and various types of disasters, exploring their effects on individuals, communities, and the environment. The course encompasses a global perspective while focusing on the disaster profile of India, considering regional and seasonal variations

**Course Outcomes:**
After successful completion of the course, students will be able to,

1. Outline disaster and disaster management cycle.
2. Summarize disaster preparedness and response activities for various types of disaster.
3. Apply various advanced techniques for disaster management.
4. Examine role of various agencies in disaster management.
5. Dissect the disaster management scenario in India.

**Prerequisite:**
Environmental Science

## Course Content

| Unit No. | Description | Hrs. |
|---|---|---|
| 01 | **Natural Disaster:** Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic, eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion. | 06 |
| 02 | **Manmade Disasters:** Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents. Disasters -A Global View, Disaster Profile of India- Regional, and Seasonal. | 06 |
| 03 | **Disaster management cycle:** Introduction to Disaster Management Cycle: Mitigation, Preparedness, Response and Recovery. Disaster Mitigation, Hazard identification and vulnerability analysis, Mitigation strategies or measures. | 06 |

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|---|---|---|
| **04** | **Disaster Preparedness, Response and Recovery:** Introduction to Disaster Preparedness, Disaster Risk Reduction (DRR), The Emergency Operation Plan (EOP). Introduction to Disaster Response, Aims of disaster response, Disaster Response Activities, Modern and traditional responses to disasters, Modern methods of disaster response, Disaster Recovery, The Recovery Plan, Disasters as opportunities for development initiatives. | **06** |
| **05** | **Role of technology in Disaster management:** Geographic Information System (GIS) and Disaster Management. GIS applications. Global Positioning System (GPS) and Disaster Management, Applications of GPS to Disaster management. Remote Sensing and its significance in Disaster Management. | **06** |
| **06** | **Role of Multiple Stakeholders in Disaster management:** Role of NGO's, Community based organizations, media, Central, State, District and Local Administration, armed forces, Police and other organizations. | **06** |

**References:**

**Codes of Practice:**

- National Disaster Management Authority (NDMA). National Disaster Management Plan 2019.
- National Disaster Management Authority (NDMA). National Disaster Management Act 2005.

**Text Books:**

- Coppola, D. P. Introduction to International Disaster Management, Elsevier USA.
- Singh R. B., Disaster Management, Rawat Publication.

**Reference Books:**

- Reiter L., Earthquake Hazard Analysis: Issues and Insight, Colombia University Press.
- Mileti D. S. Disaster by Design: A Reassessment of National Hazards in United States, The National Academic Press.

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## Note for Open Elective

An Open Elective course is included in the curriculum of S. Y. M. Tech (Semester-III), under which students need to learn either MOOC course or courses offered by department (mentioned in the curriculum). Students and concerned guides are informed to follow the guidelines given below.

### Guidelines for MOOC course under Open Elective

1. If students opt for MOOC course as an Open Elective, he/she should select this course from NPTEL platform only.
2. As three credits are allotted to open elective, selected MOOC course must be of minimum 6 weeks or 30 lectures
3. Students need to solve assignments given by platform and also, give the final certification exam at allotted NPTEL exam center.
4. Student must secure certification of NPTEL platform, otherwise he/she will not be eligible for final evaluation.
5. Final evaluation of the MOOC course will be based on oral conducted by department and marks secured in the exam conducted by NPTEL.
6. If student fails in NPTEL certification course, he or she should reregister for the course in the next semester.

### Guidelines for other courses mentioned under Open Elective:

1. Student can opt for courses mentioned in the curriculum.
2. While selecting the course, students must take care that selected course from the list is not learned in UG or PG first year curriculum.
3. Lectures of these courses will be conducted by concerned department faculty by online mode.
4. Evaluation of these courses will be as mentioned in the curriculum.

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| Class: **Second Year M. Tech Power System & Power Electronics** | Semester- **III** |
|---|---|
| Course Code: **EPP3023** | Course Name: **Dissertation Phase - I** |

| L | T | P | Credits |
|---|---|---|---|
| -- | -- | 12 | 6 |

**Course Description:** Under the guidance of faculty called as Supervisor, PG student from second year is required to do innovative and research-oriented work related to various theory and laboratory courses he/she studied during previous semesters. Dissertation work should not be limited to analytical formulation, experimentation or survey-based project. Student can undertake an interdisciplinary type project with the prior permission of DPGC from both departments. The Dissertation Phase - I consist of Synopsis Preparation and Synopsis approval by DPGC committee

**Course Outcomes:**

After successful completion of the course, students will be able to,

1. Identify research opportunities in his/her domain or multidisciplinary domains
2. Formulate the problem statement and its objectives correctly
3. Apply the principles of project management during development of the project
4. Present synopsis in logical order
5. Write synopsis of the proposed system

**Synopsis Preparation:**

Student need to carry out exhaustive literature survey with consultation of his/her supervisor for not less than 25 reputed national international journal and conference papers. Student should make the Synopsis Submission Presentation (SSP) with literature survey report to DPGC and justify about the innovativeness, applicability, relevance and significance of the work. At the time of presentation, student shall also prepare Synopsis of the work and submit to department for approval. Student shall submit synopsis of dissertation as per the prescribed format in 02 copies to department.

The synopsis shall consist of points such as Title of the project, Introduction to the project, Literature Survey, Objectives of the project, Methodology, Activity chart and References. The title should be brief, accurate, and comprehensive and clearly indicate the subject for the investigation. The introduction part should consist of area of the work and importance of the work. Literature review should examine the most current studies on the topic and presenting the significant aspects of these studies. It should also compare different authors' views about the issue and summarize the literature in terms of gap identification. It should be followed by the Problem statement formulated based on identified gap and objectives of the study. Methodology shall include information such as techniques, sample size, target populations, equipments, data analysis, etc. There should proper explanation about why proposed methodology is most suitable. It should be followed by activity chart mentioning probable duration for completion of various activities to be undertaken during dissertation work and appropriate list of references. The references should be from reputed journals such IEEE, Science direct, and Elsevier etc.

**Synopsis Approval and Evaluation by DPGC Committee**

The student should submit the synopsis duly signed by supervisor in the prescribed format to the department office. The DPGC committee is advised to conduct the Synopsis Presentation for the students of the program within the stipulated period and give approval to the synopsis with the evaluation score. The committee is advised to find the enough complexity in the dissertation work, and all committee members should remain present at the time of the presentation.

The objective of the presentation is to find quality of work undertaken by the student, student's understanding about basic concepts required to carry out the work, scope of the work, correctness of the methodology, consistency of proposed work with dissertations works of other students and student's ability to communicate his or her ideas and work. The committee can suggest modifications in the synopsis if it does not fulfill above-mentioned requirements. The student should prepare a modified synopsis by incorporating suggestions given by members and give presentation again. The supervisor must ensure that student have incorporated all suggestions

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| | |
|---|---|
| Class: **Second Year M. Tech Power System & Power Electronics** | Semester- **III** |
| Course Code: **EPP3033** | Course Name: **Dissertation Phase - II** |

| L | T | P | Credits |
|---|---|---|---|
| -- | -- | 20 | 10 |

**Course Description:** After synopsis approval, it is expected that student should start working on the selected problem as per activity chart given in the synopsis. It is expected that at least 40% dissertation work should be completed by a student in this phase.

**Course Outcomes:**

After completion of this course students will be able to:

1. Identify research opportunities in his/her domain or multidisciplinary domains.
2. Formulate the problem statement and its objectives correctly
3. Develop, simulate and implement the system by complying with desired technical specifications
4. Analyze and synthesize obtained results in theoretical and practical context
5. Present report in logical order
6. Write report of the system implementation

**Evaluation of Dissertation Phase-II**

For Stage II, evaluation is based on End Semester Examination (ESE) and In Semester Evaluation (ISE). This evaluation will be based on the work carried out during the semester. It is expected that student shall present preliminary results from his/her work during the semester with report as per prescribed format. DPGC including external examiner as expert will approve the report and progress of student.

ISE will be evaluated by DPGC and ESE will be evaluated by DPGC and one external expert. Student will submit a report (soft bound before I week of date of presentation) as per prescribed format and present to DPGC for ISE and ESE. If student is not showing satisfactory performance in then he/she will be given grace period of 2 week. After 2 weeks student will again be evaluated with grade penalty.

| Class: **Second Year M. Tech Power System & Power Electronics** | Semester- **IV** |
|---|---|
| Course Code: **EPP4013** | Course Name: **Dissertation Phase - III** |

| L | T | P | Credits |
|---|---|---|---|
| -- | -- | 12 | 6 |

Student is required to make a presentation on the progress of his/her dissertation work in front of Supervisor and DPGC. It is expected that up to this stage almost 90% of the dissertation work is completed Student will make the presentation and seek the suggestions from the supervisor and DPGC. Supervisor and DPGC will ensure that work carried out by the students till this stage is satisfactory and in compliance with synopsis of the dissertation submitted by the student. This is In Semester Evaluation (ISE).

**Course Outcomes:**

After completion of this course students will be able to:

1. Formulate the problem statement and its objectives correctly
2. Develop, simulate and implement the system by complying with desired technical specifications
3. Analyze and synthesize obtained results in theoretical and practical context
4. Present report in logical order
5. Write report of the system implementation
6. Apply the principles of project management during development of the project

**Evaluation of Dissertation Phase-III**

The evaluation (ISE) of Dissertation Phase-III shall be carried out in front of Supervisor and Internal examiner appointed by DPGC. There will be only In Semester Evaluation (ISE). The appointed members shall look at student's progress and quality of the work done. The suggestions shall be given to the student, if required. The student should keep a record of these suggestions and incorporate them. The supervisor should ensure that suggestions given are incorporated by the student. If student's progress is not as per expectation, the committee member shall issue a written notice to the student about probable extension.

| Class: **Second Year M. Tech Power System & Power Electronics** | Semester- **IV** |
|---|---|
| Course Code: **EPP4023** | Course Name: **Dissertation Phase - IV** |

| L | T | P | Credits |
|---|---|---|---|
| -- | -- | 20 | 10 |

This is the final presentation i.e. viva voce of the dissertation. Student will be allowed to make this presentation only if he has submitted duly completed and certified dissertation report. Students will make the presentation in front of supervisor, DPGC and external examiner. Examiners will check whether the dissertation work is in full compliance with synopsis of dissertation or not. Dissertation will assess on the basis quality of dissertation work, efforts taken by the student, quality of the paper(s) published on the dissertation work etc.

**Course Outcomes:**

After completion of this course students will be able to:

1. Formulate the problem statement and its objectives correctly
2. Develop, simulate and implement the system by complying with desired technical specifications
3. Analyze and synthesize obtained results in theoretical and practical context
4. Present report in logical order
5. Write report of the system implementation
6. Apply the principles of project management during development of the project

**Evaluation of Dissertation Phase-IV**

The DPGC committee is advised to evaluate the dissertation pre-submission presentation and/or system demonstration given by the students at the end of semester –IV within the stipulated period and give approval/modifications to the work done by the student along with the evaluation score.

The committee is advised to verify work completion as per the synopsis. The objective of the presentation/ demonstration is to understand techniques implemented by the student, student's own contribution in the development process, obtained results, comparison of results with existing systems, and deliverables of the dissertation work.

The committee can suggest modifications if it does not fulfill requirements. In this case, the student should modify the system in a given time span based on suggestions given by the members and give presentation again in front of committee members. The members should ensure that student has incorporated all suggestions and gives him/her approval to submit the dissertation work for final evaluation.

**Final Evaluation of Dissertation Work**:

The final evaluation of the dissertation work shall be carried out by a three-member committee, comprising of Chairman, External Examiner and concerned supervisor. This committee should be appointed by Controller of Examinations. The student should give presentation and demonstration of work carried out in front of committee members. The external examiner and supervisor should evaluate student's performance based on following points

1. Justification and clarity of the problem statement and project objectives
2. Use of appropriate, applicable and justifiable methodology to solve problem undertaken
3. Data Analysis and interpretation.
4. Overall system design
5. Experimental Results and their comparison with existing systems
6. Critical analysis of obtained results and their interpretation and correlation with project deliverables
7. Scientific justification of conclusions
8. Self-contribution of the candidate in project development irrespective of use of readymade hardware/software
9. Presentation skills

The chairman shall ensure smooth conduct of the examination.