**Ref:** UPL University /SRICT/BOS/EE/2023-24/04

# Proposed Teaching Scheme for Fourth Year Bachelor of Electrical Engineering

## Semester-VII (Electrical Engineering) Proposed Structure

| Sr. No. | Category | Course Code | Course Name | Hours Per Week | | | Total Hours | Credits | E | M | I | V | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | | | | |
| 1 | Professional Core Course | EE2430 | Power System Protection | 3 | 0 | 2 | 5 | 4 | 70 | 30 | 20 | 30 | 150 |
| 2 | Professional Core Course | EE2431 | Electrical Machine Design | 2 | 0 | 2 | 4 | 3 | 70 | 30 | 20 | 30 | 150 |
| 3 | Professional Elective - V | EE2432 / EE2433 | Professional Elective - V | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 0 | 0 | 100 |
| 4 | Professional Elective - VI | EE2434 / EE2435 | Professional Elective - VI | 3 | 0 | 2 | 5 | 4 | 70 | 30 | 20 | 30 | 150 |
| 5 | Open Elective - IV | EE2436 / EE2437 | Open Elective - IV | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 0 | 0 | 100 |
| 6 | Internship | MH2401 | Summer Internship | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 20 | 80 | 100 |
| | | | | | | **Total** | **20** | **20** | **350** | **150** | **80** | **170** | **750** |

## Semester-VIII (Electrical Engineering) Proposed Structure

| Sr. No. | Category | Course Code | Course Name | Hours Per Week | | | Total Hours | Credits | E | M | I | V | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | | | | |
| 1 | Professional Core Course | EE2438 | Power System Practice and Design | 3 | 0 | 2 | 5 | 4 | 70 | 30 | 20 | 30 | 150 |
| 2 | Professional Elective - VII | EE2439 / EE2440 | Professional Elective - VII | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 0 | 0 | 100 |
| 3 | Open Elective - V | EE2441 / EE2442 | Open Elective - V | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 0 | 0 | 100 |
| 4 | Project | MH2402 | Project | 0 | 0 | 18 | 18 | 9 | 0 | 0 | 100 | 100 | 200 |
| | | | | | | **Total** | **29** | **19** | **210** | **90** | **120** | **130** | **550** |

| Professional Elective-V | |
|---|---|
| **Course Code** | **Course Name** |
| EE2432 | Inter Connected Power System |
| EE2433 | Electric and Hybrid Vehicle |

| Professional Elective-VI | |
|---|---|
| **Course Code** | **Course Name** |
| EE2434 | Smart Grids |
| EE2435 | Electric Drives |

| Professional Elective-VII | |
|---|---|
| **Course Code** | **Course Name** |
| EE2439 | Electrical Energy Conservation & Audit |
| EE2440 | Substation Engineering |

| Open Elective-IV | |
|---|---|
| **Course Code** | **Course Name** |
| EE2436 | Electrical Materials |
| EE2437 | Testing and Maintenance of Electrical Equipment |

| Open Elective-V | |
|---|---|
| **Course Code** | **Course Name** |
| EE2441 | Internet of Things (IoT) |
| EE2442 | Artificial Intelligence (AI) |

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**Bachelor of Engineering**
**Course Code: EE2430**
**Course Name: Power System Protection**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VII

**Type of course:** Professional Core Course

**Prerequisite:** Electrical Switchgear, Electrical Power System-I & II.

**Rationale:** An electrical power system consists of generators, transformers, and transmission and distribution lines. In the case of an event of a fault, an automatic protective scheme comprising of circuit breakers and protective relays isolate the faulty section protecting the healthy part of the system. The safety of equipment and human beings is the major concern for every protection scheme. Moreover, students must develop skills for operating various controls and switchgear in the power system. They are also required to carry out remedial measures for faults/abnormalities in machines/equipment in the power system using appropriate diagnostic instruments/devices. This course attempts to develop these skills in students and hence it is a core course for all electrical engineers.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **Fundamentals of Power System Protection:** Introduction to Protective Relaying, Function of the Protective Relaying, Faults and Abnormal Operating Conditions, Desirable Qualities and Terms of Protective Relaying, System Transducers, Basic Tripping Mechanism of a relay, Types and operating principles of various protective relays. Zone of Protection. | 8 |
| 2 | **Generator Protection:** Various faults & abnormal operation conditions in a Generator, Stator & rotor faults, Transverse differential protection of a Generator, Unbalanced loading, Over speeding, Loss of excitation, Loss of prime mover. | 4 |
| 3 | **Current and Voltage Transformer:** Construction of Current Transformers, Difference Between CT Cores Used for Measurement and those Used for Protective Relays, Calculation of CT Accuracy, Factors to be Considered while Selecting a CT, Construction of Potential Transformer, Specifications of PT, Capacitor Voltage Transformer.. | 6 |

**Bachelor of Engineering**
**Course Code: EE2430**
**Course Name: Power System Protection**

| | | |
|---|---|---|
| | | |
| | **SECTION-B** | |
| **4** | **Transformer Protection:** Faults and Abnormal Conditions in Transformer, Non-electrical Protection, Overcurrent Protection, Earth Fault Protection, Inter-turn Protection, Differential Protection. Simple Differential Protection, Actual Behavior of Simple Differential Protection, Percentage Differential Protection. | **6** |
| **5** | **Distance Protection of Transmission Line:** Introduction to Distance Protection, Types of Distance Relay, Impedance, Reactance, MHO Relay, Performance of Distance Relay During Normal Load and Power Swing, Effect of Arc Resistance on Reach of Distance Relays, Comparison of Distance Relays, Distance Protection of Transmission line, Reasons for Inaccuracy of Distance Relay Reach, Three Step Protection, Trip contact configuration, 3-step protection of double end fed lines. | **8** |
| **6** | **Bus-zone Protection:** Non-Unit Protection by Back-up Relays, Differential Protection of Busbars, External and Internal Fault, Protection of Three-phase Busbars. | **4** |

**Text Books:**

1. Fundamentals of Power System Protection –Y. G. Parithankar & S. R. Bhide, 2nd edition, PHI
2. Power System Protection and Switchgear by Badari Ram , D.N Viswakarma, TMH Publications

**Reference Books:**

1. Power system protection and switchgear by Oza, Nair, Mehta, Makwana
2. Protection and switchgear, by Bhavesh Bhalja, R.P.Maheshwari, Nilesh hotani,1st edition, 2011, Oxford Publication
3. Power System Protection and Switchgear –B. Ravindranath and M. Chander

**List of suggested Practical: (Min. 10 Practical should be performed):**

1. Demonstration of over voltage protection scheme.
2. Demonstration of under voltage protection scheme.
3. Demonstration of Reverse power protection.
4. Demonstration of Generalized block diagram of Numerical Relay.
5. Demonstration of Buchholz relay for transformer protection.
6. Demonstration of differential protection of transformer.
7. Demonstration of Numerical protection of Induction motor
8. Demonstration of Block rotor protection of Induction motor.
9. Demonstration of Radial feeder protection.
10. Understand the protection schemes for different abnormal conditions in an alternator.

**Bachelor of Engineering**
**Course Code: EE2430**
**Course Name: Power System Protection**

**Course Outcomes:**

Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Explain the purposes of protection, in relation to major types of apparatus, protection principle, various conventional relays, and their design and latest developments. |
| CO-2 | Apply the knowledge of protection to protect Generator. |
| CO-3 | Understand various types of instrument transformers with their design and constructional details. |
| CO-4 | Evaluate transformer protection with the understanding of differential protection. |
| CO-5 | Analyze various distance protection schemes. |
| CO-6 | Understand the Bus Zone Protection. |

**List of Open Source Software/learning website:**

- MATLAB
- PSCAD
- EMTP
- NPTEL https://nptel.ac.in/courses/108/101/108101039/
- SWAYAM https://onlinecourses.nptel.ac.in/noc20_ee80/preview

**References used for designing a course:**

GTU

**Bachelor of Engineering**
**Course Code: EE2431**
**Course Name: Electrical Machine Design**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VII

**Type of course:** Professional Core Course

**Prerequisite:** Electrical Machine-I & II.

**Rationale:** Electrical machines serve as the backbone for the electrical power sector. The knowledge of electrical machines design is essential for manufacturing as well as the pre-installation performance analysis. The design is also essential for the practicing engineers in the research and development field. This subject deals with design of electrical machines including basics of computer aided design.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 2 | 0 | 2 | 3 | 70 | 30 | 30 | 20 | 150 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **General Aspects:** Electrical & Magnetic loadings, Specific Electric & Magnetic loadings, Factors affecting the specific electrical and magnetic loadings. | 2 |
| 2 | **Design of 3ph Induction Motors:** Main dimensions, Length of air gap, Rules for selecting rotor slots of squirrel cage machines, Design of rotor bars & slots, Design of end rings, Design of wound rotor. Simple design examples. | 5 |
| 3 | **Design of 3ph Synchronous Machines:** Main dimensions, Design of salient pole machines, Armature design, Armature parameters, Estimation of air gap length, Design of rotor, Design of damper winding, Design of field winding. Simple design examples. | 5 |

**Bachelor of Engineering**
**Course Code: EE2431**
**Course Name: Electrical Machine Design**

| SECTION-B | | |
|---|---|---|
| **4** | **Design of 3ph Transformer:** Main dimensions, kVA output for single- and three-phase transformers, Window space factor, Overall dimensions, Design of cooling tank, Methods for cooling of transformers. | **6** |
| **5** | **Introduction of Switched Reluctance & PMBLDC Motors:** General introduction, performance characteristics, design consideration, basic sizing rules. | **4** |
| **6** | **Computer aided design:** Advantage and Disadvantage of Computer aided design, Need for CAD analysis, Introduction to FEM based machine design. | **2** |

**Text Books:**

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 2010
2. R. K. Agarwal, "Principles of Electrical Machine Design", S. K. Kataria and Sons, 2009

s

**Reference Books:**

1. M.G. Say, "Theory & Performance & Design of A.C. Machines", CBS Publishers, 2005

2. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.

3. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2015.

4. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

**List of suggested Practical: (Min. 10 Practical should be performed):**

Design Sheets / Computer Aided Drawings: Students are required to submit at least three design sheets (hand drawn or computer software) in full size as term work.

**Course Outcomes:**
Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Select appropriate design parameters according to applications and rating of Electrical Machines. |
| CO-2 | Apply theoretical concepts in designing conventional electrical machines. |
| CO-3 | Understand the design aspects of special electrical machines |
| CO-4 | Estimate the machine performance based on the design outcome by data interpretation. |
| CO-5 | Analyze various parameters of design and its effects on performance. |
| CO-6 | Demonstrate the design by appropriate drawings. |

**Bachelor of Engineering**
**Course Code: EE2431**
**Course Name: Electrical Machine Design**

**List of Open Source Software/learning website:**

- E-materials available at the website of NPTEL- http://nptel.ac.in/

**References used for designing a course:**

-GTU

-Nirma University

**Bachelor of Engineering**
**Course Code: EE2432**
**Course Name: Inter Connected Power System**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VII

**Type of course:** Professional Elective-V

**Prerequisite:** Electrical Power System -I and Electrical Power System-II

**Rationale:**
This subject is offered to study of behavior of power systems during normal operating conditions and/or when subjected to disturbances by mathematical modeling of components of power systems. It also briefs the students about the modeling of power systems networks for steady state analysis.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 0 | 0 | 100 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **Introduction:** Concept of Interconnection, Hierarchical Grid arrangements, Regulatory framework Cascade Tripping, Islanding and Load dispatch center. | 04 |
| 2 | **Power system matrices:** Brief explanation of Graph theory, Primitive Network, Y-Bus formation methods, Singular transformation method, Direct method, effect of addition and deletion of shunt elements on Y-Bus, Numerical | 06 |
| 3 | **Load flow studies:** Introduction, Bus Classifications, formation of Static Load Flow Equations (LFE), Approximate method of solution of LFE, Application of Numerical method for solution of nonlinear algebraic equations - Gauss-Seidel Method, Newton Raphson Method, Fast Decoupled Load Flow Method, Comparison of different methods of solution of load flow equations, Numerical | 08 |
| | **SECTION-B** | |
| 4 | **Economic operation of power systems:** Generator operating cost, Economic operation of generators within thermal plant, Optimal operation by co-ordination equation, Penalty factor, Derivation of transmission loss formula (Kron's method), Unit commitment problem solution by dynamic programming, Numerical, Power Exchanges and Spot Pricing. Electricity Market Models (Vertically Integrated), Purchasing Agency. | 06 |

**Bachelor of Engineering**
**Course Code: EE2432**
**Course Name: Inter Connected Power System**

| | | |
|---|---|---|
| **5** | **Frequency and voltage control methods:** Speed governing mechanism, Mathematical modeling, Adjustment of Governor characteristics, Single area control, Flat frequency control, Selective frequency control, Tie line load bias control, Methods of voltage control, Numerical | **06** |
| **6** | **Power system stability:** Introduction, Mechanics of angular motion, The swing Education, transfer reactance, power relations, Steady state stability, Synchronizing power coefficient, Analysis of steady state stability, steady state stability with automatic voltage regulators, concept of shunt fault, transfer reactance during fault, reduction of power system to one machine connected to infinite bus, Transient stability, simplified transient generator model, The equal area stability criterion, solution of swing equation, Numerical | **06** |

**Text Books:**

1. Modern Power System Analysis, D. P. Kothari, I. J. Nagrath, Tata McGraw-Hill Education.
2. Power System Analysis and Stability, S.S. Vadhera, Khanna Publication.
3. Power System Analysis, Hadi Saadat, Tata McGraw-Hill Education.
4. Computer Aided Power System Analysis, G.L. Kusic, © 1986.
5. Elements of Power System Analysis by William D. Stevenson McGraw-Hill.

**Course Outcomes:**

Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Define the actual power system structure scenario and its operating mechanism in a state and country with major entities and their functions. |
| CO-2 | Develop proper mathematical model of transmission network. |
| CO-3 | Select and Identify the most appropriate numerical technique Solving Static Load Flow Equations. |
| CO-4 | Analyze the power system economics and factors effecting the economic load dispatch with and without considering network loss. |
| CO-5 | Learn and Compare the methods used for voltage and frequency regulation in electrical power network by mathematical analysis. |
| CO-6 | Demonstrate the factors which determine steady state and transient angle stability. |

**List of Open Source Software/learning website:**

https://nptel.ac.in

https://vlab.co.in

**References used for designing a course:**

Nirma University, Gujarat Technological University, AICTE.

**Bachelor of Engineering**
**Course Code: EE2433**
**Course Name: Electric and Hybrid Vehicle**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VII

**Type of course:** Professional Elective - V

**Prerequisite:** Electrical Machine-I & II, Power Electronics, Microcontroller

**Rationale:** Vehicle is an unavoidable machine for the industry, individual and government. The fuel consumptions have led the nations to be dependent on electric vehicles and needs a major change in the operation in context to energy saving. The electric vehicle has drawn attention of the designers, researchers and manufacturers for the skilled persons needed in this era. The energy saving concept has lead to hybrid electric vehicle in all the concepts for the transportation.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 0 | 0 | 100 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **Introduction to Electric Vehicles:** History of electric vehicles Social and environmental importance of electric vehicles Impact of modern drive-trains on energy supplies Basics of vehicle performance, vehicle power source characterization transmission characteristics. | 4 |
| 2 | **Electric Vehicle Power Train & Drive Train:** Concept & types of power train, different types of drive train, transmission efficiency, power train components, auxiliary systems of EV. | 7 |
| 3 | **Hybrid Electric Vehicles:** History of hybrid, Social and environmental importance of hybrid vehicle, Types–series, parallel and series-parallel configurations, I/C engine rating, control of HEV. | 7 |

**Bachelor of Engineering**
**Course Code: EE2433**
**Course Name: Electric and Hybrid Vehicle**

| SECTION-B | | |
|---|---|---|
| **4** | **Motors and Controllers:** Overview of conventional AC/DC motors, machine rating, requirements and torque – speed characteristics and speed control, Configuration and control of AC/DC motor drives. | **5** |
| **5** | **Energy Storage Systems and Charging Technology:** Battery basics – types, parameters like capacity, discharge rate, state of charge, state of discharge, depth of discharge etc., technical characteristics, battery packs, properties of batteries, selection and sizing, battery management system, testing of battery, types of chargers and charging techniques – level 1, 2 & 3, standards for chargers. | **8** |
| **6** | **Vehicular Communication and Grid integration:** Overview of vehicular communication-within vehicle, grid integration, standards for grid integration. | **5** |

**Text Book:**

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. Iqbal Husain, Electric and Hybrid Vehicles Design Fundamentals, CRC Press, Taylor and Francis Group.

**Reference Books:**

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd. 2003.
2. Sandeep Dharmeja, Electric Vehicle Battery Systems, Newnes.

**List of suggested Practical:** NA

**Course Outcomes:**
Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Correlate electric vehicles with fossil fuel driven vehicles and comprehend the basics of vehicle mechanics |
| CO-2 | Select suitable motor and drive train for Electric & Hybrid vehicles. |
| CO-3 | Understand the design aspects of Electric & Hybrid vehicles. |
| CO-4 | Measure and Estimate the various parameters of the Electric & Hybrid Vehicles. |
| CO-5 | Analyse the fundamental electrochemistry of battery and sustainability of advanced energy storage systems |
| CO-6 | Evaluate energy efficiency of the Electric & Hybrid vehicle for its drive trains. |

**Bachelor of Engineering**
**Course Code: EE2433**
**Course Name: Electric and Hybrid Vehicle**

**List of Open Source Software/learning website:**

- Online course: https://nptel.ac.in/course.html
- Ocw.mit.edu/courses
- https://www.eng.mcmaster.ca/mech/content/electric-and-hybrid-vehicles

**References used for designing a course:**

-GTU

-Nirma University

**Bachelor of Engineering**
**Course Code: EE2434**
**Course Name: Smart Grid**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VII

**Type of course:** Professional Elective – VI

**Prerequisite:** Power System Analysis

**Rationale:**
This course mainly focuses on basic fundamentals of smart grid for its implementation in the existing power system network. This course provides overview of smart grid and its applications in potential sectors of Modern power systems. It also provides detailed utility level analysis in terms of energy management, network analysis and operation of smart grids. The course also explores issues in management, control, protection and monitoring of grid with renewable energy source integration as well as in micro grids at remote location.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **Introduction to Smart Grid:** Basics of power systems, the definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India. | **04** |
| 2 | **Smart Grid Architecture:** Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, IP-based systems, power line communications, supervisory control and data acquisition system, and advanced metering infrastructure. The fundamental component of Smart Grid designs, Transmission Automation, Distribution Automation, and Renewable Integration. | **07** |
| 3 | **Tools and Techniques for Smart Grid:** Computational Techniques – Static and Dynamic Optimization Techniques for power applications such as Economic load dispatch – Computational Intelligence Techniques – Evolutionary Algorithms in the power system – Artificial Intelligence techniques and applications in power system. | **07** |

**Bachelor of Engineering**
**Course Code: EE2434**
**Course Name: Smart Grid**

| SECTION-B | | |
|---|---|---|
| **4** | **Distribution Generation Technologies:**<br>Introduction to Distribution Energy Generation, Renewable Energy Technologies – Microgrids – Storage Technologies –Electric Vehicles and plug – in hybrids – Environmental impact and Climate Change – Economic Issues. | **07** |
| **5** | **Communication Technologies in Smart Grid:**<br>Introduction to Communication Technology, Two Way Digital Communications Paradigm, Synchro- Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid. | **07** |
| **6** | **Smart-cities:**<br>Smart city pilot projects, essential elements of smart cities, active distribution networks, microgrids, distribution system automation, Reliability, and resiliency studies, and decentralized operation of a power network. | **04** |

**Text Books:**

1. S. Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 1st Edition, 2013.
2. G. Masters, "Renewable and Efficient Electric Power System", Wiley–IEEE Press, 2nd Edition, 2013.

**Reference Books:**

1. Ekanayake J.,Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications.
2. Momoh J., Smart Grid: Fundamentals of design and analysis, John Wiley & Sons.
3. Ali K., M.N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley.

**List of Suggested Practical:**

1. Modelling of One-Line diagram of given microgrid with software.
2. Prepare intelligent geospatial diagram with software.
3. Modelling of smart grid control of Intelligent Load Shedding with software.
4. Modelling of substation ground grid of microgrid.
5. Design, model & operation microgrids using a single software solution.
6. Modelling of Microgrid elements, including photovoltaic, energy storage devices, diesel generators, wind turbines, gas & steam generators, fuel cells, etc.
7. Predictive analysis & forecasting of loads and generation.
8. Demand Management, Peak Shaving & Time-of-Use Load Shifting.
9. Automatically manage & optimize control strategies under grid-connected or islanded modes.
10. Perform cable sizing, cable thermal analysis, cable ampacity, cable pulling

**Bachelor of Engineering**
**Course Code: EE2434**
**Course Name: Smart Grid**

**Course Outcomes:**
Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Introduce the basic of smart grid. |
| CO-2 | Study communication infrastructure and justify the feasibility of the same for smart grid applications. |
| CO-3 | Demonstrate techniques which can be demonstrated on tools for smart grid. |
| CO-4 | Analyze Micro grid and distributed generation as a part of modern hybrid power system. |
| CO-5 | Describe the details communication techniques which are ustlized in smart grid. |
| CO-6 | Use of load modeling techniques, Demand Side Ancillary Services Energy Management in Pricing and Energy Consumption Scheduling in smart grid operations. |

**List of Open Source Software/learning website:**
https://nptel.ac.in
https://vlab.co.in

**References used for designing a course:**

Nirma University, Gujarat Technological University, AICTE.

**Prepared By:** Mr. Ankur Gheewala, Assistant Professor, DEE

**Moderated By:** Dr. Jalpa Thakkar, HOD, DEE

**Bachelor of Engineering**
**Course Code:** EE2435
**Course Name:** Electric Drives

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VII

**Type of Course:** Professional Elective-VI

**Prerequisite:** Power Electronics – I, Power Electronics – II and Electrical Machines

**Rationale:** Today's industrial and domestic loads demands precise and smooth variable speed control. In the era of renewable energy and electric vehicle the efficient electric drive required for DC and AC motors. The major industrial electric load is induction motor. The development of compact power converters has made this possible. This course enables to develop the basics of electric drives and advantage over conventional speed control methods.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **DC motor characteristics**<br>Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation. | 5 |
| 2 | **Chopper fed DC drive**<br>Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting. | 6 |
| 3 | **Multi-quadrant DC drive**<br>Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking. | 7 |

**Bachelor of Engineering**
**Course Code:** EE2435
**Course Name:** Electric Drives

| SECTION-B | | |
|---|---|---|
| **4** | **Closed-loop control of DC Drive**<br>Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design. | **7** |
| **5** | **Induction motor characteristics**<br>Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation. | **5** |
| **6** | **Scalar control or constant V/f control of induction motor**<br>Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation. | **6** |

**Text Books:**

1. G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.
2. J. S. Chotode, U. A. Bakshi, “Electric Drives”, Technical Publications, Feb 2022.

**Reference Books:**

1. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall, 2001.
2. G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
3. W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.

**List of Practical: (Min. 10 Practical should be performed):**

1. To study the Electrical drives fundamentals.
2. To study the Speed control of PMDC motor in open loop by using Fully Controlled Rectifier.
3. To study the Speed control of PMDC motor in close loop by using Fully Controlled Rectifier.
4. To control the speed of given AC motor using Phase controlled Rectifier.
5. To control the speed of given AC motor using AC voltage controller.
6. Controlling of Stepper motor in Full and Half step mode.
7. Controlling of Stepper motor in Quarter and Sixteenth step mode.
8. To study the Speed control of PMDC motor in open loop and closed loop by using Chopper.
9. Relationship between motor voltage, Modulation Index and frequency in SPWM inverter for three phase induction motor. (Digital Mode).
10. To study traction drives.

**Bachelor of Engineering**
**Course Code:** EE2435
**Course Name:** Electric Drives

**Course Outcomes:**

Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | **Understand** the characteristics of dc motors. |
| CO-2 | **Interpret** the principles of speed-control of dc motors and induction motors. |
| CO-3 | **Manage** the power electronic converters used for dc motor and induction motor speed control. |
| CO-4 | **Compare** conventional control and drives control for dc/ac motor. |
| CO-5 | **Analyze** close loop operation of dc drives. |
| CO-6 | **Summarize** the characteristics of ac motors. |

**List of Open Source Software/learning website:**

1. Courses available through NPTEL - website: https://nptel.ac.in

**References used for designing a course:**

1. AICTE Model Curriculum-Jan 2018
2. GTU

**Bachelor of Engineering**
**Course Code: EE2436**
**Course Name: Electrical Materials**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VII

**Type of course:** Open Elective – 4
**Prerequisite:** Physics and Basic Electrical Engineering

**Rationale:**
The course is designed to give exposure to the various electrical materials which are used in electrical engineering and their applications in designing of electrical equipments. This course provides the essential knowledge in the selection of conducting, dielectric, insulating, magnetic, semiconductor and superconductor materials during designing of electrical engineering equipments.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 0 | 0 | 100 |

**Bachelor of Engineering**
**Course Code: EE2436**
**Course Name: Electrical Materials**

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| **1** | **Conductors:** Classification: High conductivity, Low resistivity materials, fundamental requirements of high conductivity materials and high resistivity materials, factors affecting conductivity and resistivity of electrical material, thermoelectric Effect: Seeback effect, Peltier effect, applications, material used for AC and DC machines. | **07** |
| **2** | **Dielectric Materials and Insulators:** Properties of gaseous, liquid and solid dielectric, breakdown in dielectric materials, mechanical and electrical properties of dielectric materials, polarization, loss angle and dielectric loss, petroleum based insulating oils, transformer oil, capacitor oils and its properties, classification of insulation (Solid) and application in AC and DC machines, solid electrical insulating materials. | **07** |
| **3** | **Semi-Conductors and Superconductors:** General concepts, energy bands, types of semiconductors: intrinsic Semi-conductors, extrinsic Semi-conductors, compound semiconductor, amorphous semiconductor, hall effect, drift, mobility, diffusion in Semiconductors, semi-conductors and their applications. | **04** |
| | **SECTION-B** | |
| **4** | **Superconductors:** Superconductivity, properties of superconductors, critical field, Meissner effect, type-I and type-II Superconductors. | **04** |
| **5** | **Magnetic Materials:** Basic terms, classification of magnetic material: diamagnetic, paramagnetic, ferromagnetic, anti- ferromagnetic and amorphous material, hysteresis loop, magnetic susceptibility. Coercive force, curie temperature, magneto-strict ion, factors affecting permeability and hysteresis loss, common magnetic materials: soft and hard magnetic materials, electric steel, sheet steel, cold rolled grain-oriented silicon steel, hot rolled grain-oriented silicon steel. | **07** |
| **6** | **Special purpose materials:** Nickel iron alloys, high frequency materials, permanent magnet materials, feebly magnetic materials, ageing of a permanent magnet, effect of impurities, Losses in Magnetic materials, Refractory Materials, Structural Materials, Radioactive Materials, Galvanization and Impregnation of materials. | **07** |

**Text Books:**

1. Electrical Engineering Materials: A.J. Dekker, PHI Publication.
2. An Introduction to Electrical Engineering Materials: C. S. Indulkar and S. Thiruvengadam, S. Chand & Co., India.

**Bachelor of Engineering**
**Course Code: EE2436**
**Course Name: Electrical Materials**

**Course Outcomes:**
Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Recall different material and its properties which are used in electrical equipments as conductor and its properties in electrical equipments. |
| CO-2 | Elucidate various types of dielectric materials and their properties in various conditions. |
| CO-3 | Analyze semi-conductor material used in electrical engineering and different effect associated with the materials. |
| CO-4 | Study superconducting material used in electrical engineering and different effect associated with the materials. |
| CO-5 | Evaluate types of magnetic materials and its behavior. |
| CO-6 | Explain various types of special purpose materials and their properties in various conditions. |

**List of Open Source Software/learning website:**
https://nptel.ac.in
https://vlab.co.in

**References used for designing a course:**

Nirma University, Gujarat Technological University, AICTE.

**Bachelor of Engineering**
**Course Code: EE2437**
**Course Name: Testing and Maintenance of Electrical Equipment**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VII

**Type of course:** Open Elective-4

**Prerequisite:** Nil

**Rationale:** Electrical Power system consists of a number of transformers, circuit breakers and other equipments which require installation, commissioning and regular maintenance to prevent permanent break down. Many times an engineering degree holder has to carryout/supervises installation, commissioning and maintenance of various electrical equipments in power stations, substations and industry. This course will enable the pass out student to understand the concepts, principles and acquire basic skills of installation, commissioning and maintenance of electrical equipments in power stations, substations and industry.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **Maintenance of Electrical Equipment:** Functions of the Maintenance Department; Reasons of failure of electrical equipment. Preventive maintenance & Breakdown maintenance: need, classification, advantages, activities Frequency of maintenance. | 4 |
| 2 | **Installation of Electrical Equipment:** Inspection of Electrical Equipment at site, Storage Electrical Equipment at site, Foundation of Electrical Equipment at site, Alignment of Electrical Machines, Tools/Instruments necessary for installation, Technical report, Inspection, storage and handling of transformer, switchgear and motors. | 7 |
| 3 | **Testing of Transformers:** General Requirements for Type, Routine and Special Tests, Measurement of winding resistance; Measurement of voltage ratio and check of voltage vector relationship; Measurement of impedance voltage/short-circuit impedance and load loss; Measurement of insulation resistance | 7 |

**Bachelor of Engineering**
**Course Code: EE2437**
**Course Name: Testing and Maintenance of Electrical Equipment**

| | | |
|---|---|---|
| | **SECTION-B** | |
| **4** | **Installation and Commissioning of Rotating Electrical Machines:** Degree of protection, cooling system, degree of cooling with IP- IC code (brief discussion), enclosures, rating of industrial rotating electric machine, installation, commissioning and protection of induction motor and rotating electric machine, drying out of electric rotating machine, insulation resistance measurement, site testing and checking, care, services and maintenance of motors, [Ref: IS 4029:2010-Guide for Testing Three Phase Induction Motors; IS 7132:1973-Guide for Testing Synchronous Machines; IS 9320:1979-Guide for Testing of Direct Current (dc) Machines] | **10** |
| **5** | **Safety Management:** Objectives, Safety Management during Operation and Maintenance, Clearance and Creep ages, Electric Shock, need of Earthing, different methods of Earthing, factors affecting the Earth Resistance, Maintenance of Battery & charger, Maintenance of Illumination system: Outdoor and Indoor system | **3** |
| **6** | **Troubleshooting:** Causes of faults in electrical equipment (Internal and external), Common troubles in electrical equipment – DC Machines, AC Machines, Transformers, Circuit breaker, underground cable, electrical Installation. Trouble shooting chart for DC Motor, DC Generator, Transformer, Synchronous Motor, Induction Motor, Circuit breaker. | **5** |

**Text Books:**

1. S. Rao, “Testing, Commissioning operation & Maintenance of Electrical Equipments”, Khanna Publications.

2. Tarlok Singh., “Installation, Commissioning, Maintenance of Electrical Equipment” S. K. Kataria & Sons.

3. B.V.S. Rao, “Installation, Maintenance and testing vol. I & II,”S. Chand & Co.

**Reference Books:**

1. Paul Gill, “Electrical Power Equipment Maintenance and Testing”, CRC Press.
2. K.B. Bhatia, “Study of Electrical Appliances and Devices”, Khanna Publishers.
3. S.K. Sharotri, “Preventive Maintenance of Electrical Apparatus” Katson Publishing House Ludhiana.
4. Relevant Indian Standards (IS Code) and IEEE Standards for- Installation, maintenance and commissioning of electrical equipments/machines.
5. Philip Kiameh,” Electrical Equipment Handbook: Troubleshooting and Maintenance”, McGraw Hill

**List of suggested Practical: (Min. 10 Practical should be performed):** Nil

**Bachelor of Engineering**

**Course Code: EE2437**

**Course Name: Testing and Maintenance of Electrical Equipment**

**Course Outcomes:**

Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Preparation of maintenance schedule of different equipment and machines |
| CO-2 | Trouble shooting chart for various electrical equipment, machines and domestic appliances |
| CO-3 | Procedure of different types of earthing for different types of electrical installations |
| CO-4 | Familiar about electrical safety regulations and rules during maintenance |
| CO-5 | Understand the process of commissioning. |
| CO-6 | Suggest the trouble shooting methods to improve life of electrical equipment. |

**List of Open Source Software/learning website:** https://nptel.ac.in/

**References used for designing a course:** GTU

**Bachelor of Engineering**
**Course Code: EE2438**
**Course Name: Power System Practice and Design**

# Shroff S.R. Rotary Institute of Chemical Technology

**Semester: VIII**

**Type of course:** Professional Core Course

**Prerequisite:** Electrical power system-I

**Rationale:**
This subject focuses on the mechanical and electrical design aspects of important power system components. In this subject students will learn basic concepts of generation, planning, transmission and distribution planning. The course also includes power system earthing and insulation co-ordination.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | Transmission lines design :<br>Requirements of transmission lines, selection of voltage for high-voltage transmission lines, choice of conductors, spacing of conductors, corona, insulators, specifications of transmission lines, surge-impedance loading of transmission lines, electrical design of transmission lines, main considerations in the mechanical design of transmission lines, sag-tension relation, stringing of transmission lines, towers | 8 |
| 2 | Design of distribution systems :<br>Development of a distribution plan, transmission and distribution systems, types of distribution systems arrangements, primary distribution design, secondary distribution design, distribution substations, calculation of distributor sizes: voltage drops, voltage regulation, Lamp flicker | 6 |
| 3 | Design of power system:<br>Introduction, selection of sizes and location of generating stations, selection and specifications of transmission lines, sizes and location of substations, interconnection. | 4 |

**Bachelor of Engineering**
**Course Code: EE2438**
**Course Name: Power System Practice and Design**

| | | |
|---|---|---|
| | **SECTION-B** | |
| **4** | Power System Earthing :<br>Objectives, definitions, tolerable limits of body currents, soil resistivity, earth resistance, tolerable step and touch voltage, actual step and touch voltage, design of earthing grid, concrete encased electrodes, tower footing resistance, measurement of earth resistance R, measurement of soil resistivity, impulse behaviour of earthing system. | **4** |
| **5** | Insulation Co-ordination:<br>Introduction, definitions, determination of line insulation, B.I.L and insulation levels of sub-station equipment, lightning arrester selection, power system over voltages, tentative selection of arrestor voltage ratings, selection of arrestor discharge currents, arrestor discharge voltage, establishment of impulse voltage level of equipment, protective margin, establishment of separation limits, location of lightening arrestor | **8** |
| **6** | Power system planning:<br>Introduction, methods of power system planning, forecasting load and energy requirements, generation planning, transmission system planning, distribution system planning, reliability of electrical power systems, methods of measuring power system reliability | **6** |

**Text Books:**

1. Electrical Power System Design – M. V. Deshpande, TMH publication
2. Electrical Power System Design – B. R. Gupta, S. CHAND

**Reference Books:**

1. A course in Electrical Power- Soni, Gupta and Bhatnagar, DhanpatRai& Sons
2. Substation Design – Satnam& Gupta, DhanpatRai andCo.
3. Electrical Power System Planning – A. S. Pabla, TMHpublication

**List of suggested Practical: (Min. 10 Practical should be performed):**

1. Designing of Transmission Line
2. Any substation Visit and study its layout
3. Designing of Transmission line towers
4. Study rural electrification by visiting a village
5. Making the drawing sheet for rural electrification
6. Study of Indian Standard : IS 282-1982
7. Study of Indian Standard : IS 398 (Part-1)
8. Study of Indian Standard : IS 398 (Part-2)
9. Study of Indian Standard : IS 3716: 1978
10. Study pipe earthing and Plate earthing

**Bachelor of Engineering**
**Course Code: EE2438**
**Course Name: Power System Practice and Design**

**Course Outcomes:**

Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Design transmission line considering electrical and mechanical aspects. |
| CO-2 | Design of primary and secondary distribution system. |
| CO-3 | Understand the Selection of sizes and location of generating stations, substations. |
| CO-4 | Analyze the basic concepts of power system earthing and measurement of earthing resistance. |
| CO-5 | Understand the basic concepts of insulation co-ordination. |
| CO-6 | Understand the concepts of the basic concepts of generation planning, transmission planning and distribution planning. |

**List of Open Source Software/learning website:**

- https://law.resource.org/pub/in/bis/ (useful website to download Indian standards)
- http://www.electrical-engineering-portal.com/
- nptel.ac.in/course.php

**References used for designing a course:** GTU

**Bachelor of Engineering**
**Course Code: EE2439**
**Course Name: Electrical Energy Conservation & Audit**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VIII

**Type of course:** Professional Elective-VII

**Prerequisite:** Fundamentals of Courses like Power Systems, Electrical Machines.

**Rationale:** The course provides basic understanding of energy audit and management. The consumption of energy is increasing day by day. One way to cope up with the increase in energy demand is to increase the production of energy which demands more investment and the other way is to conserve the energy as energy conserved/saved is twice the energy generated. Energy conservation means reduction in energy consumption but not compromising with the quality or quantity of energy production. 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.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 0 | 0 | 100 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **Energy Scenario:** Basic Energy and its various forms, Global and Indian Energy Scenario, Sector wise Electrical Energy Consumption in India, Energy Security ,Energy unit and conversions, | 4 |
| 2 | **Energy Conservation and Management:** Concept of Energy Conservation, Conservation of Electrical Energy, Energy Consumption in different areas, General Principles of Energy Management, Elements of Energy Management, different approaches of Energy Management, Salient features of Energy Conservation Act 2001, Scheme of BEE under EC Act 2001. | 6 |
| 3 | **Electrical Energy Audit:** Need of Electrical Energy Audit, Type of Electrical Audit and its Approach, Under sting Electrical Energy Cost, Energy Performance, Instruments and meters for Electrical Energy Audit, detailed Electrical Energy audit reporting. | 8 |

**Bachelor of Engineering**
**Course Code: EE2439**
**Course Name: Electrical Energy Conservation & Audit**

| SECTION-B | | |
|---|---|---|
| **4** | **Energy Measurement & Audit in Industrial Electrical System:** Electrical Energy distribution in Industry, Understating Electricity Consumption Load pattern, Understanding Electricity Bill and tariff, performance assessment of Capacitors, Performance assessment of Transformer, Performance assessment of Electric Motors, Performance assessment of Illumination of system. | **8** |
| **5** | **Electrical Energy Conservation Opportunities :** Energy Efficient Motors, VFD, Automatic power factor controllers, Energy Efficient lights LED's, Maximum demand controller, Energy Efficient Light Control, Energy Efficient Transformer | **6** |
| **6** | **Energy management systems (EMS):** Concept of Energy managed system, Benefits of Energy management system, Necessary Features of Energy Management Systems, Implementing procedure of Energy Management System, Importance of ISO 50001. | **4** |

**Text Books:**

1. Renewable energy sources and conservation N. G. Bansal, Kleemon & Meliss. Technology TMH Publication
2. Electric energy utilization and conservation S.C. Tripathi, T. M. H., Publisher

**Reference Books:**

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press.

**List of suggested Practical: (Min. 10 Practical should be performed):** NA

**Course Outcomes:**
Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Identify and assess the energy conservation/saving opportunities in different electric system |
| CO-2 | Demonstrate skills required for energy audit and management. |
| CO-3 | Understand the EC act & Energy Management Strategy. |
| CO-4 | Suggest cost-effective measures towards improving energy efficient and energy conservation. |
| CO-5 | Prepare energy flow diagrams and energy audit report |
| CO-6 | Demonstrate skills required for energy audit and management. |

**Bachelor of Engineering**
**Course Code: EE2439**
**Course Name: Electrical Energy Conservation & Audit**

**List of Open Source Software/learning website:**

- https://beeindia.gov.in/
- http://nptel.ac.in/

**References used for designing a course:**

-GTU

**Bachelor of Engineering**
**Course Code: EE2440**
**Course Name: Substation Engineering**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VIII

**Type of course:** Professional Elective – VII

**Prerequisite:** Power system protection, Electrical Measurements, Power system-I & II

**Rationale:**
This course is focused on different types of substations in power system. Different types of substation layout, its equipments, safety precautions, its grounding and communication systems are covered in this course.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 0 | 0 | 100 |

**Bachelor of Engineering**
**Course Code: EE2440**
**Course Name: Substation Engineering**

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | **Types of Substations & Bus/Switching Configurations:** Transmission substation, distribution substation, collector substation, switching substations, gas insulated substations, air insulated substations, | **06** |
| 2 | **Gas-Insulated Substations (GIS):** GIS, Single line diagram of substation, $SF_6$ insulated switchgear, Partial discharge monitoring, Loss measurement and temperature rise test, Installation and maintenance of GIS | **06** |
| 3 | **Air-Insulated Substations (AIS):** Single Bus, Double Bus, Double Breaker, Main and Transfer Bus, Double Bus, Single Breaker, Ring Bus, Breaker-and-a-Half, Comparison of Configurations | **06** |
| | **SECTION-B** | |
| 4 | **High Voltage Switching Equipment:** Ambient conditions, Disconnect switches, Load Break switches, high speed grounding switches, power fuses, circuit switches, circuit breakers. | **06** |
| 5 | **Design of Substation Grounding and Protection:** Reasons for substation grounding system, accidental ground circuit, Design criteria-Actual Touch and step voltage, soil resistivity, grid resistance, grid current, use of the design equations, selection of conductors, grounding fence, other design considerations. Lightning stroke protection-lightning parameters, empirical design methods. Substation fire protection-Fire hazards, fire protection measures, fire protection selection criterion. | **06** |
| 6 | **Substation Automation and Communications:** Introduction , components of substation automation system, automation applications, protocol Fundamentals, the structure of a SCADA communication protocol, security for substation communications, security methods, security assessment. | **06** |

**Text Books:**

1. "Electric Power Substations Engineering" by John D. McDonald, CRC Press edition 2003.
2. "Substation Design and equipments" by Partapsinghsatnam and P V Gupta, Dhanpat Rai & Sons

**Course Outcomes:**

Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Understand the criteria for selection of substations. |
| CO-2 | Describe the construction of Gas Insulated Substation. |
| CO-3 | Describe the construction of Air Insulated Substation. |
| CO-4 | Evaluate and perform the operation of Power Electronic Substations. |
| CO-5 | Demonstrate the communication structure of a substation. |
| CO-6 | Explain the protection of substation by earthing, fire, oil containment etc. |

**Bachelor of Engineering**
**Course Code: EE2440**
**Course Name: Substation Engineering**

**List of Open Source Software/learning website:**

https://nptel.ac.in
https://vlab.co.in

**References used for designing a course:**

Nirma University, Gujarat Technological University, AICTE.

**Bachelor of Engineering**
**Course Code:** EE2441
**Course Name:** Internet of Things

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VIII

**Type of course:** Open Elective - V

**Prerequisite:** Internet of Things, Artificial Intelligence

**Rationale:** IoT market is growing rapidly from installed base of about 30 billion devices in the year 2020 and expected to grow up to 75 billion devices by 2025. IoT is useful in many sectors like consumer, commercial, infrastructure, health and industry and military. Industry 4.0 is based on IoT. This course will provide opportunity to the students for contribution in IoT applications.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE (V) | PA(I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 0 | 0 | 100 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | Introduction to Internet of Things:<br>IoT: Definition and importance, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Three-layer and Five-layer model of IoT | 6 |
| 2 | IoT Communication network:<br>Architecture of IoT, Communication network: Home Area Network (HAN), Neighborhood Area Network (NAN), Field Area Network (FAN), Wide Area Network (WAN), Wireless Sensor Networks (WSNs) | 6 |
| 3 | IoT Protocols:<br>IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRa WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT | 6 |

**Bachelor of Engineering**
**Course Code:** EE2441
**Course Name:** Internet of Things

| SECTION-B | | |
|---|---|---|
| **4** | IoT Sensors/Actuators and IoT Challenges:<br>IoT: Sensor Technology, Mobile Phone Based Sensors, Medical Sensors, Neural Sensors, Environmental and Chemical Sensors, Radio Frequency Identification, Actuators, IoT Challenges: Design challenges, Development challenges, Privacy and Security challenges, Data Management and Other challenges | **6** |
| **5** | IoT Security and challenges:<br>IoT Security, Dangers, Assigning values to information, Security components, Key management, Update management, Challenges in IoT security | **6** |
| **6** | Application of IoT:<br>Smart Homes: Smart Appliances, Security and Safety. Smart Energy: Smart Meters, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Real Time Pricing, Smart grid, Smart Cities: Smart Vehicles, Smart Lighting, Smart Parking etc. | **6** |

**Text Books:**

1. Internet of Things By Rajkamal, Tata McGraw Hill publication
2. Internet of things(A-Hand-on-Approach) By Vijay Madisetti and ArshdeepBahga1st Edition, Universal Press
3. The Internet of Things: Connecting Objects By Hakima Chaouchi Wiley publication

**Reference Books:**

1. The Internet of Things – Key applications and Protocols By Olivier Hersent, David Boswarthick, Omar Elloumi,, Wiley, 2012

**Course Outcomes:**

Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Explain the function blocks, three-layer model and five-layer model of IoT |
| CO-2 | Develop an understanding of various communication network: HAN, NAN, FAN, WAN and WSNs |
| CO-3 | Describe privacy and design related challenges of IoT |
| CO-4 | Select proper sensor technology for IoT application |
| CO-5 | Describe security related challenges of IoT |
| CO-6 | Describe IoT applications in the field of Electrical Engineering |

**Bachelor of Engineering**
**Course Code:** EE2441
**Course Name:** Internet of Things

**List of Open Source Software/learning website: NA**

**References used for designing a course:**

1. AICTE
2. GTU

**Bachelor of Engineering**
**Course Code: EE2442**
**Course Name: AI**

# Shroff S.R. Rotary Institute of Chemical Technology

## Semester: VIII

**Type of course:** Open Elective-V

**Prerequisite:** Mathematics

**Rationale:**
With the usage of Internet and World Wide Web increasing day by day, the field of AI and its techniques are being used in many areas which directly affect human life. Various techniques for encoding knowledge in computer systems such as Predicate Logic, Production rules, Semantic networks find application in real world problems. The fields of AI such as Game Playing, Natural Language Processing, and Connectionist Models are also important. Student should know some programming language for AI.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credit | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE(V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

**Course Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | **SECTION-A** | |
| 1 | Introduction to AI :<br>The AI Problems, The Underlying Assumption, What Is An AI Techniques, The Level of The Model, Criteria For Success, Some General References, One Final Word. | 4 |
| 2 | Problems, State Space Search & Heuristic Search Techniques :<br>Defining The Problems as a State Space Search, Production Systems, Production Characteristics, Production System Characteristics and Issues in the Design of Search Programs, Generate-And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis. | 10 |
| 3 | Knowledge Representation Issues:<br>Representations And Mappings, Approaches To Knowledge Representation. | 4 |
| | **SECTION-B** | |
| 4 | Symbolic Reasoning Under Uncertainty:<br>Introduction To No monotonic Reasoning, Logics For Non-monotonic Reasoning. | 4 |

| | | |
|---|---|---|
| **5** | Genetic Algorithms:<br>A Peek into the Biological World, Genetic Algorithms (GAs), Significance of the Genetic Operators, Termination Parameters. | **8** |
| **6** | Application of AI in Electrical Engineering:<br>Applications of AI in power systems operation and control for solving problem of Load forecasting. | **6** |

**Text Books:**

1. "Artificial Intelligence" -By Elaine Rich And Kevin Knight (2nd Edition) Tata Mcgraw-Hill
2. "Artificial Intelligence: A Modern Approach" -By Stuart Russel, Peter Norvig, PHI

**Reference Books:**

1. "Introduction to Prolog Programming" -By Carl Townsend.
2. "PROLOG Programming For Artificial Intelligence" -By Ivan Bratko( Addison-Wesley)
3. "Programming with PROLOG" –By Klocksin and Mellish.

**List of suggested Practical: (Min. 10 Practical should be performed):**

NA

**Course Outcomes:**

Students will be able to:

| Sr. No. | CO statement |
|---|---|
| CO-1 | Understand AI Applications and advances in Artificial Intelligence. |
| CO-2 | Understand the search technique procedures applied to real world problems |
| CO-3 | Understand and use various types of logic and knowledge representation schemes. |
| CO-4 | Analyze Symbolic Reasoning Under Uncertainty. |
| CO-5 | Understand various parameters of Genetic Algorithms. |
| CO-6 | Evaluate application of AI in Power System problems. |

**List of Open Source Software/learning website:**

https://nptel.ac.in/courses/106105077
https://www.sciencedirect.com/journal/artificial-intelligence

**References used for designing a course:** GTU