DEPT. ELECTIVES

ELECTRICAL AND ELECTRONICS ENGINEERING

B.Tech.

COURSE CONTENTS

I SEM & II SEM

22EE801 GREEN ENERGY TECHNOLOGIES

Source: https://www.vectorstock.com/royalty-free-vector/green-energy-technology-isometric-flowchart-vector-17196398

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basic Engineering Products.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the types, purpose and operation of renewable energy technologies. The objective of the course is to understand the implementation of energy conversion technologies in the following renewable energy resources, solar, wind biomass and tidal.

MODULE –1

UNIT-1 **8L+8T+0P=16 Hours**

SOLAR ENERGY:
Solar radiation on the earth surface, Sun-Earth angles, Solar thermal power generation technologies.

UNIT-2 **8L+8T+0P=16 Hours**

SOLAR PHOTOVOLTAICS:
Photovoltaic effect, Working of a solar cell, Current equation of a solar cell, Performance characteristics of a PV cell, Parameters of PV Cell, Effect of irradiation and temperature, Solar PV module and array interconnections, Concept of shading on PV module, Ratings of a PV module, Classification of PV systems, Design of PV system.

PRACTICES:

- Determining the best location for Solar PV panels and collectors using solar path finder.
- To study solar pond.
- To study solar distillation.
- To study solar photovoltaic system.

MODULE –2

UNIT-1 **8L+8T+0P=16 Hours**

WIND ENERGY:

Nature of wind, Site selection, Principle of wind energy conversion, Betz limit, Power regulation, Classification of wind mills, aero dynamics, Design of wind turbine for water pumping applications.

UNIT-2 **8L+8T+0P=16 Hours**

BIOMASS AND TIDAL ENERGY:

Biomass: Photosynthesis, Biomass energy conversion technologies, Design of biogas plant.

Tidal Energy: Spring tide, Neap tide, Daily and monthly variation, Tidal range, Modes of tidal power generation, Types of tidal power.

PRACTICES:

- Familiarization with wind energy gadgets.
- Study of wind turbine system for water pumping application.
- To study biogas plants.
- Study of different types of Gasifiers.

SKILLS:

- ✓ *Understand the fundamentals of solar flat plate collectors, concentrating solar collectors and familiar with the solar low, medium and high temperature applications.*
- ✓ *Design of solar panel to obtain required voltage.*
- ✓ *Understand layout and functioning of wind power plants.*
- ✓ *Differentiate between various biomass energy conversion routes.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Examine various applications of solar collectors.	Analyze	1	1, 2, 3, 7, 9, 11
2	Evaluate efficiency of Solar cell and to understand the functioning of Photon devices.	Evaluate	1	1, 2, 3, 7, 9, 11
3	Examine different components and their functioning in wind power plants.	Analyze	2	1, 2, 3, 7, 9, 11
4	Compare the operation of tidal and OTEC power plants.	Analyze	2	1, 2, 3, 7, 9, 11
5	Develop biomass plant.	Create	2	1, 2, 3, 7, 9, 11

TEXT BOOKS:

1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", 1st edition, Oxford University Press, 2012.
2. G.S.Sawhney, "Non-Conventional Energy Resources", 1st edition, PHI Learning, 2012.

REFERENCES BOOKS:

1. S.P. Sukhatme and J.K.Nayak., "Solar Energy", 3rd edition, Tata Mc-Graw Hill Education Private Limited, 2010.
2. Chetan Singh Solanki, "Solar Photovoltaic: Fundamentals, Technologies and Application", PHI Learning Pvt., Ltd., 2009.
3. Rajput R.K., "Non-Conventional Energy Sources and Utilization", revised edition, S. Chand & Co., 2012.
4. G.D. Rai, "Non-Conventional Energy Sources", 4th edition, Khanna Publishers, 2011.

22EE802 ELECTRIC VEHICLES

Source: https://jmkresearch.com/electric-vehicles-published-reports/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Power Electronics; Industrial Electric Drives; Electrical Machines-I and Electrical Machines-II.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of this course is to introduce configuration of electrical vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components, design optimization and energy management.

MODULE - 1

UNIT-1 **8L+8T+0P=16 Hours**

INTRODUCTION TO HYBRID ELECTRIC VEHICLES AND CONVENTIONAL VEHICLES:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, Vehicle power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance.

UNIT-2 **8L+8T+0P=16 Hours**

HYBRID ELECTRIC DRIVE-TRAINS, ELECTRIC DRIVE-TRAINS AND ELECTRIC PROPULSION UNIT:

Hybrid Electric Drive-Trains: Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

Electric Drive-Trains: Basic concept of electric traction, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies, Fuel efficiency analysis.

Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives.

PRACTICES:

- Developing real-life drive cycles for 2-wheelers, 3-wheelers, cars and buses.
- Extracting features from the drive cycles for sizing motors and converters.
- Control of motors using the drive cycles.

MODULE-2

UNIT-1 **8L+8T+0P=16 Hours**

ENERGY STORAGE AND SIZING THE DRIVE SYSTEM:

Energy Storage: Introduction to energy storage requirements in hybrid and electric vehicles, battery based energy storage and its analysis, Fuel cell based energy storage and its analysis, Hybridization of different energy storage devices.

Sizing the Drive System: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, Sizing the power electronics, Selecting the energy storage technology.

SKILLS:

- ✓ *Selection of E – motors for Electric Vehicles- BLDC/PMSM/ INDUCTION/ SynR MOTORS*
- ✓ *Lithium Batteries and Battery Pack Design for Electric & Hybrid Vehicle Application*
- ✓ *Motor Control Technology for Electric Vehicle applications*
- ✓ *Powertrain Sizing Calculation Procedure and Practice Problems*

UNIT-2 **8L+8T+0P=16 Hours**

COMMUNICATIONS, SUPPORTING SUBSYSTEMS AND ENERGY MANAGEMENT STRATEGIES:

Communications, Supporting Subsystems: In vehicle networks- CAN.

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, Classification of different energy management strategies, Comparison of different energy management strategies.

PRACTICES:

- Study of accessories required for Scooter Hybrid Conversion.
- Lithium Batteries and Battery Pack Design for Electric & Hybrid Vehicle Application.
- Power train Sizing Calculation Procedure and Practice Problems.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.	Apply	1	1, 2, 3, 4, 7, 9, 11
2	Choose proper energy storage systems for vehicle applications.	Apply	2	1, 3, 7, 9, 11
3	Design and develop basic schemes of electric vehicles and hybrid electric vehicles.	Analyse	1	1, 3, 7, 9, 11
4	Choose proper energy management strategies for vehicle applications.	Analyse	2	1, 3, 9, 11
5	dentify various communication protocols and technologies used in vehicle networks.	Create	2	1, 2, 5, 9, 11

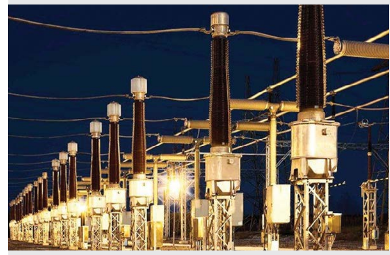
TEXT BOOKS:

1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2. Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.

REFERENCE BOOKS:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.

22EE803 HIGH VOLTAGE ENGINEERING



Source: https://electrical-engineering-portal.com/download-center/books-and-guides/electrical-engineering/high-voltage-practice-theory

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basic Electromagnetism and Electro Statics.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the basic concepts of high voltage generation, measurements and testing of high voltage equipment's in the system. The objective of the course is to understand failure mechanisms of solids, liquids and gaseous insulation and their usage in high voltage underground cables, overhead transmission lines and transformers.

MODULE - I

UNIT-1 **8L+8T+0P=16 Hours**

ELECTRO STATIC FIELDS, CONTROL AND ESTIMATION:

Electric field intensity, Electric strength, Classification of electric fields, Control of electric field intensity, Basic equations for potential and field intensity in electrostatic fields, Analysis of electric field intensity in homogenous and multi-dielectric electric fields, Numerical methods for estimation of electric field intensity, Applications of insulating materials in transformers, Rotating machines, Circuit breakers, Cable power capacitors and bushings.

UNIT-2 **8L+8T+0P=16 Hours**

BREAKDOWN MECHANISM OF GASEOUS, LIQUID AND SOLID INSULATING MATERIALS:

Mechanism of breakdown in gases, Townsend's first ionization coefficient, Cathode processes, Secondary effects, Townsend's second ionization coefficient, Townsend breakdown mechanism, Streamer or kanal mechanism of spark, Paschen's law, Penning effect, Breakdown in non-uniform fields, Principles of breakdown in solid and liquid dielectrics.

PRACTICES:

- Study filtration and treatment of Transformer Oil.
- Study solid the electrics used in power apparates.
- Determine dielectric strength of Transformer Oil.

MODULE - 2

UNIT-1 **8L+8T+0P=16 Hours**

GENERATION OF IMPULSE VOLTAGES AND CURRENTS:

Rectifier circuits, Cockcroft- Walton voltage multiplier circuit, Electrostatic generator, Generation of high AC voltages by cascaded transformers, Series resonant circuit, Definitions, Generation of high DC impulse generator circuits, Analysis of impulse generator circuit, Multistage impulse generator circuit, Triggering of impulse generator, Impulse current generation.

UNIT-2 **8L+8T+0P=16 Hours**

MEASUREMENT OF HIGH VOLTAGES AND CURRENTS AND HIGH VOLTAGE TESTING OF ELECTRICAL EQUIPMENT:

Measurement of High Voltages and Currents: Sphere gap, Uniform field spark gap, Rod gap, Electrostatic voltmeter, Generating voltmeter, Fortes cue method, Resistive and capacitive voltage dividers, Measurement of high DC, AC and impulse currents.

SKILLS:

- ✓ *Determine break down strength of different insulation mediums.*
- ✓ *Suggest appropriate insulation for a given electrical equipment.*
- ✓ *Design of high voltage DC generator circuit.*
- ✓ *Design of CVT for measuring High voltages.*
- ✓ *Test electrical equipment's at different voltage levels.*

High Voltage Testing of Electrical Equipment: Layout of high voltage laboratory with major testing and measuring equipment's, Determination of their ranges and ratings, Earthing system, Electromagnetic shielding and protective fencing; Testing - overhead line insulators, cables, bushings, Power capacitors, power transformers, circuit breakers; IEC, ANSI, IEEE and Indian standards for testing electrical equipment.

PRACTICES:

- Generation and measurement of direct voltage.
- Electrostatic generator.
- Generation of high AC voltages by cascaded transformers.
- Generation and measurement of AC voltage - sphere gap.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Design the insulation of HV power equipment.	Analyze	1	1,2,9
2	Understand the Breakdown mechanism of Gas, Liquid and solid insulation.	Analyze	2	1,3,7
3	Estimate electric field intensity of different electrode configurations.	Analyze	2	1,2,12
4	Employ Non-destructive test techniques to assess the quality of insulation of high voltage equipment.	Evaluate	2	1,2,9,12

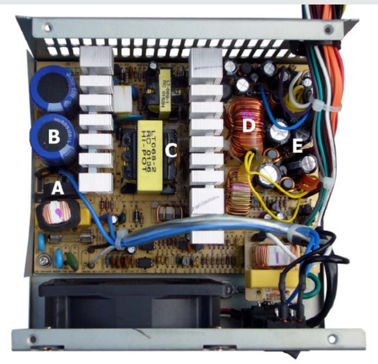
TEXT BOOKS:

1. E. Kuffel, W.S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publishers, 2011.
2. M.S. Naidu and Kamaraju, "High Voltage Engineering", Mc Graw Hill Education (India) Private Limited, 2013.

REFERENCE BOOKS:

1. Ravindra Arora and Wolfgang Mosch, "High Voltage Insulation Engineering", New Age International Publishers, 2016.
2. C.L. Wadhwa, "High voltage Engineering", New Age International Publishers, 2012.

22EE804 SWITCH MODE POWER CONVERSION



Source: https://en.wikipedia.org/wiki/Switched-mode_power_supply

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Power Electronics.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the analysis of various SMPS based converters and their modeling. The objective of course is to understand the concept of SMPS and choose proper SMPS based converters for building drivers.

MODULE–1

UNIT-1 **16L+4T+0P=20 Hours**

SMPS:

Introduction to SMPS, Circuit description of SMPS, Types of SMPS, Different PWM techniques for SMPS.

UNIT-2 **08L+12T+0P=20 Hours**

FLY BACK CONVERTER AND FORWARD CONVERTER:

Fly back converter : Analysis of flyback converter, State space model of flyback converter, Design of control circuit for flyback converter, Applications, Numerical problems.

Forward Converter: Analysis of forward converter, State space model of forward converter, Design of control circuit for forward converter, Applications, Numerical problems.

PRACTICES:

- Study the difference between linear power supplies and switch mode power supplies.
- Study the performances of frequency with modulation and pulse with modulation.
- Derive the minimum inductance required for CCM mode of operation in flyback converter.
- Derive the minimum inductance required for CCM mode of operation in forward converter.

MODULE–2

UNIT-1 **6L+4T+0P=10 Hours**

LUO CONVERTER:

Analysis of luo converter, State space model of luo converter, Design of control circuit for luo converter, Applications, Numerical problems.

UNIT-2 **18L+12T+0P=30 Hours**

HALF BRIDGE AND FULL BRIDGE CONVERTER:

Analysis of half bridge and full bridge converters, State space model of half bridge and full bridge converter, Design of control circuit for half bridge and full bridge converters, Applications.

PRACTICES:

- Study the digital hysteresis current controller.
- Study the voltage mode pulse width controller.
- Derive the transfer function of half bridge inverter using small signal analysis.
- Derive the transfer function of full bridge inverter using small signal analysis.

SKILLS:

- ✓ *Develop SMPS for a particular application.*
- ✓ *Develop mathematical model of flyback, forward luo converter.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify different SMPS circuits and PWM techniques for SMPS.	Apply	1	1, 2, 9, 11
2	Design and analyse fly back converter.	Analyze	1	1, 2, 9, 11
3	Design and analyse forward converter.	Create	1	1, 2, 3, 9, 11
4	Design and analyse luo converter.	Create	2	1, 2, 3, 9, 11
5	Design and analyse half bridge and full bridge converter.	Create	2	1, 2, 3, 9, 11

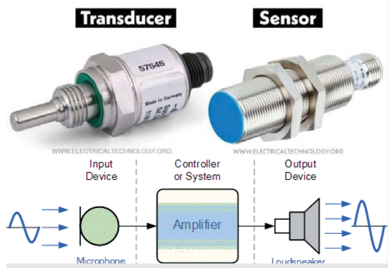
TEXT BOOKS:

1. M.H. Rashid ,"Power Electronics Handbook", Elsevier Publication, 2015.
2. Kjeld Thorborg, "Power Electronics – In Theory and Practice", 1st edition, Overseas Press, 2005.

REFERENCE BOOKS:

1. Ned Mohan, Tore. M.Undeland and William. P. Robbins, "Power Electronics Converters, Applications and Design", 3rd edition, Wiley, 2022.
2. M.H. Rashid, "Power Electronics Circuits, Devices and Applications", 3rd edition, Prentice Hall of India, 2011.

22EE805 SENSORS AND TRANSDUCERS



Source : https://www.electricaltechnology.org/2021/12/difference-between-sensor-transducer.html

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Electrostatics; electromagnetism and Measurement system.

COURSE DESCRIPTION AND OBJECTIVES:

This course make students familiar with the constructions and working principle of different types of sensors and transducers. It also deals with the measuring instruments and the methods of measurement and the use of different transducers.

MODULE–1

UNIT-1 **12L+8T+0P=20 Hours**

FUNDAMENTALS OF SENSORS AND MOTION, PROXIMITY AND RANGING SENSORS:

Fundamentals of Sensors: Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

Motion, Proximity And Ranging Sensors: Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer.,– GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT-2 **12L+8T+0P=20 Hours**

FORCE, MAGNETIC AND HEADING SENSORS:

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto.

PRACTICES:

- Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters.
- Predict correctly the expected performance of various sensors.
- Locate different type of sensors used in real life applications.
- Predict correctly the expected performance of various sensors.

MODULE–2

UNIT- 1 **16L+8T+0P=24 Hours**

RESISTANCE TRANSDUCERS & CAPACITANCE TRANSDUCERS:

Classification of transducers – Selection of transducers - Static characteristics –Dynamic characteristics.

Resistance Transducers - Principle of operation, construction details, characteristics and applications of potentiometer - Strain gauge – types - Resistance temperature detector (RTD)- Thermistor –Hot-wire anemometer.

Inductance and Capacitance Transducers - Induction potentiometer – Variable reluctance transducer – Eddy current transducer –Principle of operation, construction details, characteristics and applications of Linear Variable Differential Transducers.

Capacitive transducer and types - Differential arrangement – Variation of dielectric constant for measurement of liquid level - Dynamic microphone.

SKILLS:

- ✓ *Explain the concept, application and functional elements of sensors and transducers*
- ✓ *Choose proper sensor*
- ✓ *Test measuring systems to evaluate performance*
- ✓ *Design a real-life instrumentation system.*

UNIT-2 **8L+8T+0P=16 Hours**

Modern Transducers - Piezoelectric transducer – Hall Effect transducer – Magneto resistor - Digital displacement transducer– Fiber optic sensor - Introduction to SQUID sensor, Touch screen sensor, Smart Transducer, MEMS and Introduction to linearization of transducer.

PRACTICES:

- Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers.
- Design of a real-life instrumentation system.
- Analyse different types of errors that can occur during the measurement, and the methods.
- Used to correct the measurement errors.
- Compare accuracy and precision with suitable examples.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the various sensors in the Automotive and Mechatronics applications.	Apply	1,2	1,2,9,12
2	Apply the principles of various smart sensors for real time applications.	Apply	2	1,2,3,9,12
3	Expertise in various calibration techniques and signal types for sensors.	Analyze	1,2	1,2,6,9
4	Implement systems with different sensors for real time applications.	Evaluate	2	1,2,9,12

TEXT BOOKS:

1. Ernest O.Doebelin,- Measurement systems, 6th Edition, Tata McGraw Hill Education Private Ltd, New Delhi, 2012.
2. A.K. Sawhney,- A course in Electrical & Electronic Measurement and Instrumentation, DhanpatRai and Company Private Limited, Reprint: 2014.

REFERENCE BOOKS:

1. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall of India, 2010.
2. John P.Bentley, Principles of Measurement Systems, 4th Edition, Pearson Education, 2004.
3. Neubert H.K.P., Instrument Transducers – An Introduction to their Performance and Design, Oxford University Press, Cambridge, 2003.

22EE806 SPECIAL ELECTRICAL MACHINES

Source: https://padeepz.net/ee6703-special-electrical-machines-question-bank-regulation-2013-anna-university/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basic of Electromagnetism and DC and AC machines.

COURSE DESCRIPTION AND OBJECTIVES:

To impart knowledge on the following Topics

- Construction, principle of operation, control and performance of stepping motors.
- Construction, principle of operation, control and performance of switched reluctance motors.
- Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
- Construction, principle of operation and performance of permanent magnet synchronous motors.
- Construction, principle of operation and performance of other special Machines.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

STEPPER MOTOR:

Constructional features –Principle of operation –Types – Torque predictions – Linear Analysis – Characteristics – Drive circuits – Closed loop control – Concept of lead angle - Applications.

UNIT-2 **12L+0T+8P=20 Hours**

SWITCHED RELUCTANCE MOTORS (SRM):

Constructional features –Principle of operation- Torque prediction–Characteristics Steady state performance prediction – Analytical Method – Power controllers – Control of SRM drive- Sensor less operation of SRM – Applications.

PRACTICES:

- Select and Evaluate the performance of stepper motor for suitable application.
- Develop the closed loop Control of stepper motor.
- Identify the Switched reluctance motor for suitable application and obtain the performance of motor.
- Obtain the Open Loop Speed control of Switched Reluctance Motor.
- Obtain the Open Loop Speed control of Switched Reluctance Motor.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

PERMANENT MAGNET BRUSHLESS D.C. MOTORS:

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMF and Torque equations- Power Converter Circuits and their controllers – Characteristics and Applications.

UNIT-2 **12L+0T+8P=20 Hours**

PERMANENT MAGNET SYNCHRONOUS MOTORS AND OTHER SPECIAL MACHINES:

Constructional features -Principle of operation – EMF and Torque equations - Phasor diagram – performance characteristics and Applications. Constructional features – Principle of operation and Characteristics of Hysteresis motor- Synchronous Reluctance Motor and applications.

SKILLS:

- ✓ *Analyse the characteristics of Stepper motor.*
- ✓ *Identify the Characteristics and applications of Switched Reluctance Motor.*
- ✓ *Describe the Construction, principle of operation and performance of permanent magnet synchronous motors.*
- ✓ *Describe the Construction, principle of operation and performance of other special Machines.*

PRACTICES:

- Obtain the speed control of BLDC motor for suitable application.
- Simulate and analyse the closed loop speed control of BLDC motor.
- Select and Evaluate the performance of PMSM for suitable application.
- Analyse the performance of Hysteresis motor for suitable application.
- Select and Evaluate the performance of Synchronous motor for suitable application.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Describe the operation and control of switched reluctance motors.	Apply	1	1, 2, 9, 11
2	Acquire the knowledge on operation and control of stepper motor.	Analyse	1,2	1, 2, 9, 11
3	Analyse the operation and control of permanent magnet brushless D.C. motors.	Analyse	1	1, 2, 9, 11
4	Describe the operation and control of permanent magnet synchronous motors.	Analyse	2	1, 2, 9, 11
5	Select a special Machine for a particular socital application.	Analyse	2	1, 2, 7, 9, 11

TEXT BOOKS:

1. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2. T. Kenjo and S. Nagamori, Permanent Magnet and Brushless DC Motors, Clarendon Press, London, 1988.

REFERENCE BOOKS:

1. R.Srinivasan, Special Electrical Machines, Lakshmi Publications, 2013.
2. T.J.E.Miller,' Brushless Permanent-Magnet and Reluctance Motor Drives', Oxford University Press, 1989.

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22EE807 OPTIMIZATION TECHNIQUES

Source: https://www.tppl.org.in/2020/fourth-sem/348-optimization-techniques.html

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basic arithmetic and Algebra, soft computing techniques.

COURSE DESCRIPTION AND OBJECTIVES:

Analyze the advantages and disadvantages associated with the large-scale optimization techniques when applied to problems from Electrical and Computer Engineering applications. Implement selected optimization algorithms commonly used in machine learning and other areas of Electrical and Computer Engineering. Design and implement appropriate optimization approaches for specific Electrical and Computer Engineering applications.

MODULE - 1

UNIT – 1 **12L+8T+0P=20 Hours**

Introduction to Optimization

- Introduction, Historical development.
- Statement of an Optimization Problem.
- Classification of Optimization Problems.
- Optimum design concepts: Definition of Global and Local optima – Optimality criteria Linear programming.
- Review of Linear programming methods for optimum design – Post optimality analysis.

UNIT – 2 **12L+8T+0P=20 Hours**

Non-Linear programming: Unconstrained Optimization

- Gradient-based methods:
  - o Cauchy's steepest descent method.
  - o Newton's method.
  - o Conjugate gradient method.
- Steepest descent method.

  Non-Linear programming: Constrained Optimization
- Direct methods.
- Indirect methods (Penalty function methods).

PRACTICES:

- The rectangle of the largest area that can be enclosed in a fence of the given length.
- The largest volume box with the given surface area.
- Solve Non-linear Programming problems of some kinds.
- Implement the Linear programming techniques using C or any other optimization software.

MODULE – 2

UNIT – 1 **12L+8T+0P=20 Hours**

Modern methods of Optimization-I

- Genetic Algorithms.
- Simulated Annealing.

SKILLS:

- ✓ *Formulate real-life problems with Linear Programming.*
- ✓ *Solve the Linear Programming models using graphical and simplex methods.*
- ✓ *Apply dynamic programming to optimize multi stage decision problems.*
- ✓ *Apply modern optimization methods to optimize multi stage decision problems.*

- Neural-Network-based Optimization.
- Fuzzy optimization techniques.
- Tabu Search.

UNIT – 2 **12L+8T+0P=20 Hours**

Modern methods of Optimization-II

- Particle Swarm Optimization.
- Ant Colony Optimization.
- Meta-heuristics - Nature-inspired Optimization.

PRACTICES:

- Shortest route taken by a salesperson visiting various cities during one tour.
- Optimizing the usage of power in a residential building.
- Implement the different evolutionary algorithms techniques using C or any other optimization software.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply different types of Optimization Techniques in engineering problems and learn the linear programming methods for optimum design.	Apply	1	1, 2, 9, 11
2	Implement constrained Optimization methods.	Apply	1	1, 2, 3, 5, 9, 11
3	Apply Unconstrained Optimization methods.	Apply	1	1, 2, 3, 5
4	Implement modern optimization techniques such as Genetic Algorithms, Ant colony optimization, etc.	Apply	2	1, 2, 5, 9, 11
5	Demonstrate optimization techniques to solve real-time problems.	Analyse	2	1, 2, 3, 9, 11, 12

TEXT BOOKS:

1 Rao S. S. – 'Engineering Optimization, Theory and Practice' – New Age International Publishers – 2012 – 4th Edition.

2 Igor Griva, Stephen G. Nash, Ariela Sofer – 'Linear and Nonlinear Optimization' - Society for Industrial and Applied Mathematics, Philadelphia, March 2009.

REFERENCE BOOKS:

1 K Deb, "Multi Objective Optimization Using Evolutionary Algorithms", John Wiley and Sons, ISBN: 0-471-87339-X, July 2001.

2 Yang, Xin-She, "Optimization techniques and applications with examples", John Wiley & Sons, ISBN 10: 1119490626, 2018.

3 Ke-Lin Du, M. N. S. Swamy, "Search and Optimization by Metaheuristics: Techniques and Algorithms Inspired by Nature", Birkhäuser Basel, ISBN: 3319411926, 2016.

22EE808 ADVANCED CONTROL SYSTEMS

Source: https://www.controleng.com/articles/know-when-to-migrate-a-process-control-system/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Control Systems.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the mathematical modelling, different methods of analysis and design of nonlinear systems. The objective of the course is to understand the concept of state variable analysis, controllability and observability, and applying them for stability analysis techniques.

MODULE–1

UNIT-1 **12L+0T+8P=20 Hours**

STATE SPACE ANALYSIS:

State space representation, Solution of state equation, State transition matrix, Canonical forms – Controllable, Observable and jordan canonical forms.

Tests for controllability and observability for continuous time systems.

UNIT-2 **12L+0T+8P=20 Hours**

MODAL CONTROL:

Effect of state feedback on controllability and observability, Design of state feedback control through pole placement, Full order observer and reduced order observer.

PRACTICES:

- Time response analysis of non linear system using MATLAB.
- State space modeling of DC generator.
- Design of state feedback controller and simulation for a motor using MATLAB.
- Design of state observer and simulation for a motor using MATLAB.

MODULE–2

UNIT- 1 **12L+0T+8P=20 Hours**

DESCRIBING FUNCTION ANALYSIS AND STABILITY ANALYSIS:

Describing Function Analysis: Introduction to nonlinear systems, Types of nonlinearities, Describing functions, Describing function analysis of nonlinear control systems.

Stability Analysis: Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems, Direct method of Lyapunov for the linear and nonlinear continuous time autonomous systems.

UNIT- 2 **12L+0T+8P=20 Hours**

PHASE-PLANE ANALYSIS:

Introduction to phase-plane analysis, Method of isoclines for constructing trajectories, Singular points, Phase-plane analysis of nonlinear control systems.

SKILLS:

- ✓ *Model any nonlinear system (Electrical, Mechanical, Electro-mechanical).*
- ✓ *Analyze non-linear systems using describing function and phase plane technique.*
- ✓ *Analyze stability using lyapunov method.*
- ✓ *Design state feedback controller for the given specifications.*
- ✓ *Design state observer for the given specifications.*

PRACTICES:

- Study of characteristics of non linearities.
- Describing function analysis of non linear system using MATLAB.
- Phase-plane analysis of non linear system using MATLAB.
- Lyapunov stability analysis of non linear system using MATLAB.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Model the given electrical/electro-mechanical systems in state space and find its solution.	Apply	1	1,2,6,9,11
2	Model nonlinear systems, and analyse stability using describing function method.	Apply	1,2	1,2,9,11
3	Analyse the stability of various nonlinear systems using the phase plane trajectory.	Apply	2	1,2,3,9,11
4	Identify the stability of the given linear and nonlinear system using Lyapunov stability theory.	Evaluate	2	1,2,9,11
5	Design pole placement controller and/or observer for the given system to achieve desired specifications.	Create	2	1,2,3,9,11

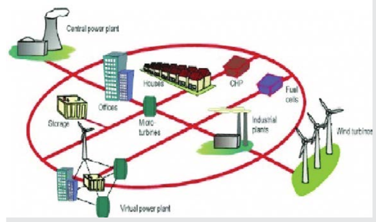
TEXTBOOKS:

1. M. Gopal, “ Modern Control System Theory”, New Age International Publishers, 5th edition, 2015.
2. Katsuhiko Ogata, “ Modern Control Engineering “ ,5th edition, Prentice Hall of India Private Ltd., New Delhi, 2010.

REFERENCEBOOKS:

1. I. J. Nagrath and M. Gopal, “Control Systems Engineering”, 2nd edition, New Age International (P) Limited, 2010.
2. Benjamin C Kuo, “Automatic Control system”, 1st edition, Prentice Hall of India Private Ltd., New Delhi, 2009.

22EE809 ADVANCED POWER ELECTRONICS



Source: https://www.controleng.com/articles/know-when-to-migrate-a-process-control-system/

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Power Electronics.

COURSE DESCRIPTION AND OBJECTIVES:

The course is aimed to provide exposure of advanced power electronic converters that are utilized by the industries and are not covered in the basic courses on Power Electronics.

MODULE-1

UNIT-1 **6L+4T+0P=10 Hours**

ADVANCED SOLID STATE DEVICES:

MOSFET, IGBT, GTO, IGCT, Power modules, Intelligent power modules, Gating circuits, Thermal design, Protection, Digital signal processors used in their control.

UNIT-2 **18L+12T+0P=30 Hours**

RESONANT CONVERTERS AND MULTI - LEVEL CONVERTERS:

Resonant Converters: Need of resonant converters, Classification, Load resonant converters, Resonant switch converters, Zero-voltage switching DC-DC converters, Zero current switching DC-DC converters, Clamped voltage topologies.

Multi - Level Converters: Need for multi-level converters, Concept of multi-level, Topologies: Diode clamped, Flying capacitor and cascaded H-bridge; Features and relative comparison of these configurations applications, Introduction to carrier based PWM technique for multi-level converters.

PRACTICES:

- Design a 4 quadrant control switch.
- Study the A316J IGBT driver.
- Compares the differences between diode clamped, flying capacitor and cascaded H-bridge multi-level inverter.
- Study the different pulse width modulation.

MODULE - 2

UNIT-1 **9L+6T+0P=15 Hours**

MULTI PULSE CONVERTERS:

Concept of multi-pulse, Configurations for m-pulse (m = 12, 18, 24….) converters, Different phase shifting transformer (Y-1, Y-2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Applications.

UNIT-2 **15L+10T+0P=25 Hours**

SOLID STATE CONTROLLERS FOR MOTOR DRIVES:

Vector control and direct torque control of induction, Synchronous, Permanent magnet synchronous reluctance motors, Permanent magnet brushless dc (PMLDC) and switched reluctance motors, LCI (load commutated inverter) fed large rating synchronous motor drives, Energy conservation and power quality improvements in these drives.

SKILLS:

- ✓ *Expertise in Matlab/Simulink (or equivalent software) for simulating power electronics systems in various applications.*
- ✓ *Develop a resonant converter.*
- ✓ *Design carrier based PWM technique.*
- ✓ *Know the hardware design of power electronics circuits and systems.*

PRACTICES:

- Study the phase shift transformer required to realize the 12, 18 & 24 pulse converter.
- Study the VSI fed induction motor drive with common voltage mitigation.
- Compare between permanent magnet synchronous motor or brushless DC motor.
- Study the power quality improvement in the case of induction motor drive.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze and simulate resonant converters.	Apply	1	1, 3, 5, 9, 11
2	Evaluate different DC-DC voltage regulators.	Analyze	1	1, 2, 9, 11
3	Evaluate various multi-level inverter configurations.	Analyze	1	1, 2, 3, 9, 11
4	Evaluate Solid State Control devices for various drives and the power quality improvements.	Analyze	2	1, 2, 9, 11
5	Select appropriate phase shifting transformer for a multi-pulse converter.	Evaluate	2	1, 9, 11

TEXT BOOKS:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics Converters, Applications and Design”, 3rd edition, Wiley, 2022.
2. Muhammad H.Rashid, “Power Electronics - Circuits, Devices and Applications”, Prentice HallofIndia, 3rd edition, 2011.

REFERENCE BOOKS:

1. Bin Wu, “High Power Converters and AC Drives”, John Willey & Sons, Inc., 2017.
2. Muhammad H. Rashid, “Power Electronics Hand book”, 3rd edition, Elsevier, 2015

22EE810 POWER QUALITY

Source: https://www.servomax.in/blog/power-quality-solution-methods/

Hours Per Week :

L	T	P	C
3	2	0	4

PRE-REQUISITE KNOWLEDGE: Power Electronics, Electrical circuit Analysis.

COURSE DESCRIPTION AND OBJECTIVES:

This course is to familiarize students with the reasons of load generated harmonics present in the supply and the methods for their suppression.

MODULE - 1

UNIT-1 **12L+8T+0P=20 Hours**

INTRODUCTION TO POWER QUALITY:

Concept of Power Quality: Frequency variations, voltage variations- sag and swell, waveform distortion –dc offset, harmonics, inter-harmonics, notching and noise.

Fundamentals of Harmonics: Representation of harmonics, waveform, harmonic power, measures of harmonic distortion; Current and voltage limits of harmonic distortions: IEEE, IEC, EN, NORSOK.

UNIT-2 **12L+8T+0P=20 Hours**

CAUSE AND EFFECTS OF HARMONICS:

Causes of Harmonics: 2-pulse, 6-pulse and 12-pulse converter configurations, input current waveforms and their harmonic spectrum; Input supply harmonics of AC regulator, integral cycle control, cyclo converter, transformer, rotating machines, ARC furnace, TV and battery charger.

Effect of Harmonics: Parallel and series resonance, effect of harmonics on static power plant – transmission lines, transformers, capacitor banks, rotating machines, harmonic interference with ripple control systems, power system protection, consumer equipments and communication systems, power measurement.

PRACTICES:

- Study the input current response of 2, 6, 8, 12 pulse converter by using MAT Lab.
- Study the IEEE 519 standards.
- Study the effect of resonance on a radial feeder line.
- Study the switching characteristics of a transformer.

MODULE - 2

UNIT-1 **12L+8T+0P=20 Hours**

ELIMINATION OF HARMONICS USING PASSIVE FILTERS:

Elimination / Suppression of Harmonics: High power factor converter, multi-pulse converters using transformer connections (delta, polygon).

Passive Filters: Types of passive filters, single tuned and high pass filters, filter design criteria, double tuned filters, damped filters and their design.

SKILLS:

- ✓ *Able to study the effect of non linear loads on power quality.*
- ✓ *Able to study the effect of ground loop.*
- ✓ *Able to study the effect of harmonics on energy meter reading.*
- ✓ *Able to study the effect of voltage sag on electrical equipment.*

UNIT-2 **12L+8T+0P=20 Hours**

ELIMINATION OF HARMONICS USING ACTIVE FILTERS:

Active Power Filters: Compensation principle, classification of active filters by objective, system configuration, power circuit and control strategy. Single-phase active filter, principle of operation, expression for compensating current, concept of constant capacitor voltage control; Three-phase active filter: Operation, analysis and modelling; Instantaneous reactive power theory.

Unified power quality conditioner, voltage source and current source configurations, principle of operation for sag, swell and flicker control.

PRACTICES:

- Study the performance of 24 pulse converter.
- Study the difference between linear and un-linear load.
- Study the use of PLL circuit in Grid connected converters.
- Derive the compensation currents in case of unbalanced nonlinear load.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the generating source for harmonics.	Analyze	1	1, 2, 9, 11
2	Examine the compensation of load in presence of harmonics and imbalance.	Analyze	2	1, 9, 11
3	Design compensators at distribution level to mitigate power quality issues.	Evaluate	2	1, 3, 9, 11
4	Design the passive filters to supress for harmonics .	Evaluate	2	1, 3, 9, 11

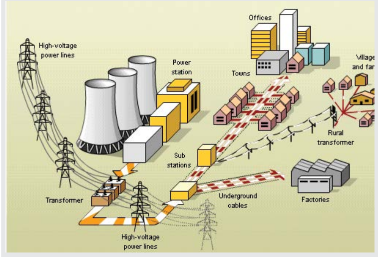
TEXT BOOKS:

1. A. Ghosh and G. Ledwich, “Power quality enhancement using custom power devices”, Kluwer Academic Publication, 2002.
2. Roger C. Dugan et al, “Electrical power systems quality”, Tata McGraw-Hill, 2002.

REFERENCES:

1. Angelo Baggini (Ed), “Handbook of power quality”, John Wiley & Sons, 2008.
2. H. Akagi et al , “Instantaneous power theory and application to power conditioning”, IEEE Press, 2007.

22EE811 ADVANCED POWER SYSTEM ANALYSIS



Source: https://www.mathworks.com/matlabcentral/fileexchange/59097-power-system-analysis-lab-experiments-using-matlab-manual?s_tid=prof_contriblnk

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Power system analysis, Electric circuit analysis.

COURSE DESCRIPTION AND OBJECTIVES:

To perform steady state analysis and fault studies for a power system of any size, explore the estimation of different states of a power system. To impart in depth knowledge on different methods of power flow solutions. To perform optimal power flow solutions, execute short circuit analysis and sensitivity factors for contingency analysis.

MODULE–1

UNIT-1 **12L+0T+8P=20 Hours**

Introduction- Digital computers in power system simulations, System view point, Hierarchy of transmission and distribution system, nature and scope of power system studies.

Transformers - Two winding and auto-transformers, tap changing transformer and loads. Y-bus formation, Bus impedance formulation, algorithms.

UNIT-2 **12L+0T+8P=20 Hours**

Load Flow Studies- Analytical formulation, methods of load flow solutions, Bus mismatch and convergence criteria, Newton Raphson method, concept of decoupled methods.

Fault calculation using Z-bus, unsymmetrical faults, positive, negative and zero sequence impedance matrices, problems

PRACTICES:

- Formation of Bus admittance and bus impedance matrix for tap changing transformers and loads
- Power flow analysis of standard test system for Newton Raphson method using MATLAB.
- Power flow analysis of standard test system for Fast decoupled power flow using MATLAB.
- Short circuit analysis of a synchronous machines without and with load.
- Analysis of unsymmetrical fault using Z bus and sequence impedances.

MODULE–2

UNIT-1 **8L+0T+6P=14 Hours**

Optimal Load Flow Study of Power System- state estimation, method of least squares-test for bad data, power system State Estimation.

UNIT-2 **16L+0T+10P=26 Hours**

Power system control and management – normal operation, abnormal operation, contingency analysis - single outages, multiple outages, DC power flow and sensitivity factors for contingency analysis.

PRACTICES:

- contingency analysis for Single outages.
- contingency analysis for multiple outages.
- Implementation of DC load flow using MATLAB.
- Power system state estimation.
- Optimal power flow solutions for the standard power system network.

SKILLS:

- ✓ *Formulate basic power flow problem.*
- ✓ *Apply different numerical techniques to solve power flow problem.*
- ✓ *Perform contingency analysis in power system.*
- ✓ *Classify different short circuit faults in power systems.*
- ✓ *Understand the stability problem in power system subjected to disturbances.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	To analyze a Power System Network using graph theory.	Analyze	1	1, 2, 9, 11
2	To interpret the formation of Network matrices.	Analyze	1	1, 2, 9, 11
3	To construct the necessity of load flow studies and various methods of Analysis.	Analyze	2	1, 3, 9, 11
4	To examine short circuit analysis using ZBus.	Evaluate	2	1, 2, 19, 11
5	Perform transient stabilities; determine transient stability using equal area criterion.	Evaluate	2	1, 2, 9, 11

TEXT BOOKS:

1. Electrical Energy Systems Theory -O.I.Elgerd, McGraw Hill Education; 2nd edition (1 July 2017).
2. Computer Methods in Power system Analysis -A.H.El.Abiad, Medtech, 2019.

REFERENCE BOOKS:

1. Computer Techniques in Power System Analysis, 2nd ed – M.A. Pai - Tata Mc Graw Hill Publications, 2014.
2. P. Kundur, “Power System Stability and Control”, 1st edition, Mc-Graw Hill, 2016.

22EE812 ENERGY STORAGE TECHNOLOGIES

Source: https://www.weforum.org/agenda/2021/04/renewable-energy-storage-pumped-batteries-thermal-mechanical/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Engineering Chemistry.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the concepts of energy storage with major focus on electrochemical storage including ionic batteries, fuel cells and super-capacitors. The course will cover operating principles, physics behind them, characterization methods and advantages of each scheme. The objective of the course is to know the possibilities of energy storage and various technologies involved in it.

MODULE –1

UNIT-1 **8L+8T+0P=16 Hours**

ENERGY STORAGE AND MECHANICAL ENERGY STORAGE SYSTEMS:

Energy Storage: Role of energy storage system, Components of energy storage system, Pros and cons of energy storage systems, Types of energy storage systems.

Mechanical Energy Storage Systems: Pumped Hydro Storage System, Flywheel energy storage system, Compressed air energy storage system.

UNIT-2 **8L+8T+0P=16 Hours**

THERMAL ENERGY STORAGE:

Thermal energy storage systems, Sensible heat storage, Latent heat storage, Working, Thermo-chemical energy storage, Solar pond storage system.

PRACTICES:

- Theoretical investigation of flywheel-based energy storage in off-grid power plants using renewable energy.
- Study of solar pond.
- Familiarization with different Solar Energy thermal storage technologies.

MODULE –2

UNIT-1 **8L+8T+0P=16 Hours**

BATTERY ENERGY STORAGE AND FUEL CELLS:

Battery Energy Storage: Charging and Discharging Mechanisms, Battery Performance characteristics of batteries, Types of batteries, battery terminology, Comparison of batteries.

Fuel Cells: Introduction to fuel cells, components of fuel cells, Types of fuel cells, Performance characteristics of fuel cells, fuel cell stack, fuel cell vehicles.

UNIT-2 **8L+8T+0P=16 Hours**

HYDROGEN STORAGE AND OTHER STORAGE TECHNOLOGIES:

Hydrogen Storage: Hydrogen storage options - Compressed gas, Liquid hydrogen, Hydride, Chemical storage, Comparisons. Safety and management of hydrogen.

SKILLS:

- ✓ *Select appropriate batteries for specific applications.*
- ✓ *Identify appropriate energy storage options.*
- ✓ *Familiar with the solar thermal storage applications.*
- ✓ *Familiar with the performance behavior, operational issues and challenges for all major types of fuel cells.*

Other Storage Technologies: Superconducting magnetic energy storage, Super capacitor energy storage, Comparison of different energy storage technologies.

PRACTICES:

- Charging and discharging characteristics of a battery.
- Study and comparison of various designs of gas flow fields to PEM fuel cells and cell stack performance.
- Study and comparison of various hydrogen storage techniques.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Choose the necessity and usage of different energy storage schemes for different purposes.	Apply	1	1,2,5,7,9,11
2	Analyse the operational mechanisms of each energy storage system.	Analyze	1	1,2,3,7,9,11
3	Apply the concept of solar thermal energy storage for various applications.	Apply	1	1,2,3,5,7,9,11
4	Utilize thermodynamics and electrochemistry principles.	Apply	2	1,2,3,5,7,9,11
5	Characterize and analyze electrochemical energy storage.	Analyze	2	1,2,3,5,7,9,11

TEXT BOOKS:

1. A.G.Ter-Gazarian, “Energy Storage for Power Systems”, Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN – 978-1-84919-219-4), 2011.
2. Archie.W.Culp, “Principles of Energy Conversion”, Mc Graw-Hill Inc., 1991.

REFERENCE BOOKS:

1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt,” Energy Storage in Power Systems” Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.
2. A. R. Pendse, “Energy Storage Science and Technology”, SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN – 13:9789380090122), 2011

22EE813 ENERGY AUDIT, CONSERVATION AND MANAGEMENT

Source: https://besten.in/2021/06/energy-conservation-and-energy-audit-in-industries/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Power Generation Systems, Electrical Machines.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with audit, conservation and management of electrical energy. The objective of the course is to introduce the concepts of energy efficient lighting, space heating and ventilation. The course also deals with methods for improving energy efficiency in different electrical systems.

MODULE–1

UNIT-1 **8L+8T+0P=16 Hours**

BASIC PRINCIPLES OF ENERGY MANAGEMENT:

Energy scenario, Energy Management, Energy Conservation, Energy Audit, Energy Instruments.

UNIT-2 **8L+8T+0P=16 Hours**

CO-GENERATION, TRI-GENERATION AND WASTE HEAT RECOVERY:

Co-generation, Tri-generation and Waste heat recovery Technologies.

PRACTICES:

- Overview of energy scenario and introduction to energy conservation.
- Heat recovery system and its potential opportunities a case study.
- Special features of co-generation plants and their types.

MODULE–2

UNIT-1 **8L+8T+0P=16 Hours**

ENERGY EFFICIENCY IN ELECTRICAL SYSTEMS:

Modification / Replacement of existing systems, Energy efficient motors, Demand side management Techniques.

UNIT-2 **8L+8T+0P=16 Hours**

ENERGY EFFICIENCY IN SPACE HEATING AND VENTILATION:

Water and Space Heating methods, Ventilation, Air-conditioning, Energy conservation methods.

PRACTICES:

- Analysis of electric bill based on tariff of Industrial consumer to reduce energy usage and electric bill.
- Estimate energy saving by improving power factor and load factor a case study.
- Prepare a sample energy audit questionnaire for VFSTR,VU facilities.

SKILLS:

- ✓ *Implement the energy conservation measures for various equipment.*
- ✓ *Analyse different lighting schemes.*
- ✓ *Design a capacitor bank for an energy utility.*
- ✓ *Perform energy audit for an energy utility.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Examine and determine the performance of various lighting systems.	Apply	1	1, 2, 6, 7, 9, 11
2	Analyse effective energy management policies, methods and planning.	Analyze	1	1, 2, 6, 8, 9, 11
3	Carryout energy audit and economic analysis.	Analyze	1	1, 2, 6, 7, 9, 11
4	Design energy utilization systems for heat recovery.	Create	2	1, 2, 3, 4, 6, 7, 9, 11
5	Design a capacitor bank to address low power factor issues.	Create	2	1, 2, 3, 4, 6, 7, 9, 11

TEXT BOOKS:

1. W. R. Murphy and F. Mc Kay Butterwort, “Energy Management”, 1st edition, Elsevier publications, 2012.
2. Umesh Rathore, “Energy Management”, 2nd edition, S. K. Kataria & Sons, 2014.

REFERENCE BOOKS:

1. Paul O’ Callaghan, “Energy Management”, 1st edition, Mc-Graw Hill Book Company, 1998.
2. V.K Mehta and Rohit Mehta, “Principles of Power Systems”, 1st edition, S. Chand & Company Ltd., 2009.
3. Reay, D.A., “Industrial Energy Conservation”, 1st edition, Pergamon Press, 2003.
4. John. C. Andreas, “Energy Efficient Electric Motors”, 2nd edition, Marcel Inc. Ltd., 1995.

22EE814 SMART GRID TECHNOLOGIES

Source: https://www.digi.com/blog/post/what-is-the-smart-grid-and-how-enabled-by-iot

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Power Electronics; Power System Protection; Analysis and Operation of Power Systems.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the working definitions of smart grid. Distribution generation technologies and voltage control in micro grid system. The objective of the course is to understand the features of smart grid, architecture of smart grid communication technologies for smart grid.

MODULE –1

UNIT-1 **8L+8T+0P=16 Hours**

INTRODUCTION TO SMART GRID:

Working definitions of smart grid and associated concepts – smart grid functions, Traditional power grid and smart grid; New technologies for smart grid, Advantages, Indian smart grid, Key challenges for smart grid.

UNIT-2 **8L+8T+0P=16 Hours**

SMART GRID ARCHITECTURE:

Components and architecture of smart grid design, Review of the proposed architectures for smart grid; Fundamental components of smart grid.

PRACTICES:

- Necessity and evolution of smart grid with policies.
- Review on conventional grid and smart grid.
- Challenges of smart grid.
- proposed architectures for smart grid.
- National and International Initiatives in Smart Grid.

MODULE –2

UNIT-1 **8L+8T+0P=16 Hours**

DISTRIBUTION GENERATION TECHNOLOGIES:

Renewable energy technologies, Micro grids, Storage technologies, Electric vehicles and plug–in hybrids, Environmental impact and climate change, Economic issues.

UNIT-2 **8L+8T+0P=16 Hours**

COMMUNICATION TECHNOLOGIES AND SMART GRID AND SCADA FUNCTIONS:

Communication Technologies and Smart Grid: Communication Technology, Synchro-Phasor Measurement Units (PMUs), Wide Area Measurement Systems (WAMS).

Scada Functions: Introduction to SCADA: Grid operation and control, Difficulties in operating the large power systems manually, Need for SCADA operation, Advantages of SCADA operation; Data acquisition, Monitoring and event processing.

SKILLS:
- ✓ *Acquainted with the concepts of smart grid components.*
- ✓ *Demonstrate the components of Distribution Generation Technologies*
- ✓ *Device the various functions of distribution management system*
- ✓ *Apply the various techniques of communication, computer networking and cyber security for smart metering systems.*
- ✓ *To analyse application of smart grid technology in power system through case studies.*

PRACTICES:
- Wide area measurement techniques.
- Review on Advanced Metering Infrastructure (AMI).
- Importance of electric vehicles and grid integration issues.
- SCADA system hardware architecture.
- SCADA system software architecture.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply features of Smart Grid in the context of Indian Grid.	Apply	1	1,2,3
2	Implement the architectures for smart grid	Apply	1	3,4
3	Analyse the Distribution Generation Technologies	Analyse	2	1.2.4
4	Analyse the operation of PMUs, PDCs, WAMS	Analyse	2	1,2,3,4
5	Analyse the functionalities of SCADA and	Analyse	2	1,2,4

TEXT BOOKS:

1. Stuart Borlase, “Smart Grids, Infrastructure, Technology and Solutions”, CRC Press, 2013.
2. Ali Keyhani, “Design of Smart Power Grid Renewable Energy Systems”, Wiley IEEE, 1st Edition, 2011.

REFERENCE BOOKS:

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong. Wu, Akihiko Yokoyama and Nick Jenkins, “Smart Grid: Technology and Applications”, Wiley, 2012.
2. James Momoh, “Smart Grid: Fundamentals of Design and Analysis”, Wiley, IEEE Press, 2012.
3. A.G. Phadke and J.S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2010.

SKILLS:
✓ *A*

22EE815 ENERGY SYSTEM ECONOMICS

Source: https://www.ecowatch.com/india-solar-market-2118202661.html

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Principles of Management.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the economic concepts and theories related to the supply and utilization of energy resources and technologies at various levels – economy, firm and individual. The objective of the course is to introduce economic tools, empirical data for economic analysis in the energy system domain to support and influence the decision making in the context of resource planning and energy efficiency to take economically sound decisions.

MODULE –1

UNIT-1 **8L+8T+0P=16 Hours**

ENERGY AND ECONOMICS:

Role and significance of renewable energy sources for sustainable economic development and social transformation, Energy and GDP, GNP and its dynamics, Introduction to economics, Flow in an economy, Law of supply and demand, Concept of engineering economics, Engineering efficiency, Economic efficiency, Scope of energy economics; Element of costs, Marginal cost, Marginal revenue, Sunk cost, Opportunity cost; Break-even analysis and V-ratio.

UNIT-2 **8L+8T+0P=16 Hours**

VALUE ENGINEERING:

Make or buy decision, Interest formula and their applications, Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment present worth factor, Equal payment series capital recovery factor, Uniform gradient series annual equivalent factor, Effective interest rate and examples.

PRACTICES:

- Overview of energy scenario and introduction to energy conservation.
- Energy management concept, principles, benefits and its significant.
- Energy conservation system a case study.

MODULE –2

UNIT-1 **8L+8T+0P=16 Hours**

CASH FLOW:

Methods of comparison of alternatives, Present worth method, Future worth method, Annual equivalent method, Rate of return method and examples; Payback period, NPV, IRR and cost benefit analysis.

UNIT-2 **8L+8T+0P=16 Hours**

REPLACEMENT AND MAINTENANCE ANALYSIS:

Types of maintenance, Types of replacement problem, Determination of economic life of an asset, Replacement of an asset with a new asset, Capital recovery with return and concept of challenger and defender.

SKILLS:
- ✓ *Compare economic and energy parameter of India with other countries.*
- ✓ *Compare various available alternatives.*
- ✓ *Perform replacement and maintenance analysis.*
- ✓ *Perform life cycle analysis of a product.*

DEPRECIATION:

Introduction, Straight line method of depreciation, Declining balance method of depreciation, Sum of the years digits method of depreciation, Sinking fund method of depreciation / Annuity method of depreciation, Service output method of depreciation.

PRACTICES:
- An approach to study energy audit, energy monitoring and targeting.
- Replacement and maintenance analysis in renewable energy system a case study.
- Depreciation in renewable energy system a case study.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Promote different economic principles.	Apply	1	1,2,6,7,8,11
2	Apply various economic policies and application of theories.	Apply	1	1,2,6,7,8,9,11
3	Examine various methods of depreciation.	Analyze	2	1,2,6,7,8,9,11
4	Analyze financial and economic concepts for a given problem.	Analyze	2	1,2,6,7,8,9,11
5	Evaluate different alternatives for better economic efficiency.	Evaluate	2	1,2,6,7,8,9,11

TEXT BOOKS:

1. Panneer Selvam. R, “Engineering Economics”, 1st edition, Prentice Hall of India Ltd, 2001.
2. Subhes C.Bhattacharyya., “Energy Economics”, 1st edition, Springer, 2011.

REFERENCE BOOKS:

1. Chan S.Park, “Contemporary Engineering Economics”, 1st edition, Prentice Hall of India, 2002.
2. U. Aswath Narayana, “Green Energy: Technology, Economics and Policy”, 1st edition, CRC press, 2010.
3. L.J. Truett and D.B. Truett, “ Managerial Economics- Analysis, Problems & Cases”, Wiley India, 8th edition, 2004.
4. Suma Damodaran, “Managerial Economics”, 1st edition, Oxford University Press, 2006.

22EE816 FLEXIBLE AC TRANSMISSION SYSTEMS

Source: https://www.power-technology.com/uncategorized/newsalstom-grid-to-supply-flexible-ac-transmission-systems-to-quwayyah-substation-in-saudi-arabia-281113/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Electrical circuit Analysis, Power Transmission and Distribution, Power Electronics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamental concepts of FACTS technology which are emerging in the area of power systems. The objective of this course is to understand the role of FACTS technology in delivering quality power at bulk levels.

MODULE - 1

UNIT-1 **8L+8T+0P=16 Hours**

POWER FLOW IN AC SYSTEMS:

Introduction - Power Flow in AC Systems, Loading capability Limits, Dynamic stability considerations, controllable parameters, basic types of FACTS controllers.

UNIT-2 **8L+8T+0P=16 Hours**

VOLTAGE SOURCE CONVERTERS:

Single phase and 3-phase full wave bridge converters, transformer connections for 12, 24, 48 pulse operation, 3 level voltage source converters, PWM converters.

PRACTICES:

- Study the different types of FACTS controllers used in the present Grid.
- Implement 120° and 180° mode of operation for voltage source converter.
- Study the phase shift transformers used in 12, 24 & 48 pulse converter.
- Study the voltage at different on radial feeder line with the surge impedance loading.

MODULE - 2

UNIT-1 **8L+8T+0P=16 Hours**

STATIC SHUNT COMPENSATION:

Objectives of shunt compensation, Voltage in stability and its prevention, power oscillations and damping, controllable VAR generation, variable impedance type VAR generators.

UNIT-2 **8L+8T+0P=16 Hours**

SVC AND STATCOM:

Dynamic performance, transient stability enhancement with SVC and STATCOM- operating principle – V-I characteristics. Series Compensation & UPFC: Series capacitive compensation, transient stability improvement, Thyristor controlled series capacitor (TCSC), thyristor control power angle regulator (TCPAR), Unified power flow controller.

PRACTICES:

- Study the shunt compensation under unbalanced load.
- Study the differences between SVC and STATCOM.
- List the merits of unified power flow controller.
- Study the point of connection required to connect the STATCOM in case of radial feeder line.

SKILLS:
- ✓ *Analyze the performance of given transmission system with and without FACTS technology.*
- ✓ *Review the static devices for series and shunt control.*
- ✓ *Select suitable FACTS device for specific power quantity/ quality.*
- ✓ *Identify suitable location of FACTS controller for given transmission system.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Categorize the importance of FACTS devices.	Analyze	1	1, 2, 9, 11
2	Analyze different FACTS devices in Transmission system.	Analyze	1, 2	1, 2, 9, 11
3	Bring out the advantages of FACTS technology.	Evaluate	1, 2	1, 2, 9, 11
4	Design of FACTS controllers for different Power system applications.	Create	2	1, 2, 3, 9, 11

TEXT BOOKS:

1. N.G. Hingorani and L.Guygi, “Understanding FACTS Devices”, IEEE Press Publications, Standard Publishers, Delhi 2001.
2. Mohan Mathur, R., Rajiv. K. Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc., 2018.

REFERENCE BOOKS:

1. E. Achaet. Al. John Wiley, “FACTS: Modelling and Simulation in power Networks”, London, UK, 2004.
2. P. Kundur, “Power System Stability and Control”, McGrawHill, 1994.

22EE817 SCADA SYSTEMS AND APPLICATIONS

Source : https://instrumentationtools.com/applications-of-scada/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Power system analysis.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the architecture of SCADA system and its components. It describes the basic tasks of SCADA as well as their typical applications like Transmission and Distribution sector operations.

MODULE-1

UNIT-1 **8L+8T+0P=16 Hours**

INTRODUCTION TO SCADA :

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in utility automation, Industries.

UNIT-2 **8L+8T+0P=16 Hours**

SCADA SYSTEM COMPONENTS:

Schemes- Remote terminal unit (RTU), Intelligent electronic devices (IED), Programmable logic controller (PLC), Communication network, SCADA server, SCADA/ HMI Systems.

PRACTICES:

- Analysis about evolution of SCADA.
- Operation of Programmable logic controller (PLC).
- Demonstration about the SCADA server.

MODULE-2

UNIT-1 **8L+8T+0P=16 Hours**

SCADA ARCHITECTURE AND SCADA COMMUNICATION:

SCADA Architecture: Various SCADA architectures, Advantages and disadvantages of each system, Single unified standard architecture - IEC 61850.

SCADA Communication: Various industrial communication technologies, Wired and wireless methods and fiber optics.

UNIT-2 **8L+8T+0P=16 Hours**

SCADA APPLICATIONS:

Utility applications, Transmission and distribution sector, Operations, Monitoring, Analysis and improvement; Industries - oil, gas and water; Case studies, Implementation, Simulation exercises.

PRACTICES:

- Simulation exercises on SCADA system.
- SCADA on transmission and distribution sector.
- Demonstration about the various SCADA architectures.

SKILLS:

- ✓ *Formulate logical programming for SCADA system.*
- ✓ *Operate RTU, IED, PLC and SCADA system.*
- ✓ *Develop SCADA Communication system.*
- ✓ *Design SCADA system for industrial applications*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Understand SCADA architecture and SCADA system components.	Apply	1	1, 2, 5, 9, 11
2	Analyze the operation of RTU, IED, PLC, and SCADA/HMI Systems.	Analyze	1	1, 2, 5, 9, 11
3	Evaluate the basic tasks of Supervisory Control Systems SCADA) as well as their typical applications.	Analyze	1	1, 2, 3, 5, 9, 11
4	Apply SCADA systems in transmission and distribution sectors and industries.	Evaluate	2	1, 2, 5, 9, 11
5	Analyze the SCADA communication system, various industrial communication technologies and open standard communication protocols.	Create	2	1, 2, 5, 9, 10, 11

TEXT BOOKS:

1. Stuart A. Boyer, “SCADA-Supervisory Control and Data Acquisition”, Instrument Society of America Publications, 2004.
2. Gordon Clarke and Deon Reynders, “Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems”, Newnes Publications, Oxford, 2004.

REFERENCE BOOKS:

1. William T. Shaw, “Cybersecurity for SCADA Systems”, PennWell Books, 2006.
2. David Bailey and Edwin Wright, “Practical SCADA for Industry”, Newnes Publisher, 2003.

22EE818 PLUG-IN ELECTRIC VEHICLES IN SMART GRID

Source: https://www.torquenews.com/4723/difference-between-hybrid-ev-extended-range-ev-and-fully-electric-ev

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Power Systems; Power Electronics; Grid Integration and Smart Grid.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of this course is to introduce impact of charging on electric vehicles, EV demands and impacts, control strategies for EV's to support frequency and voltage and modeling for smart grid and electric vehicles.

MODULE-1

UNIT-1 **8L+8T+0P=16 Hours**

VEHICLE ELECTRIFICATION & IMPACT OF CHARGING STRATEGIES:

Introduction, Impact of charging strategies, EV charging options and infrastructure, energy, economic and environmental considerations, Impact of EV charging on power grid, effect of EV charging on generation and load profile, Smart charging technologies, Impact on investment.

UNIT-2 **8L+8T+0P=16 Hours**

INFLUENCE OF EVS ON POWER SYSTEM:

Introduction, identification of EV demand, EV penetration level for different scenarios, classification based on penetration level, EV impacts on system demand: dumb charging, multiple tariff charging, smart charging, case studies.

PRACTICES:

- Developing control strategies for vehicle electrification.
- Evocation of EV charging methods by using case studies.
- Implementing methods for identification of EV demand.

MODULE-2

UNIT-1 **8L+8T+0P=16 Hours**

FREQUENCY CONTROL RESERVES & VOLTAGE SUPPORT FROM EVS:

Introduction, power system ancillary services, electric vehicles to support wind power integration, electric vehicle as frequency control reserves and tertiary reserves, voltage support and electric vehicle integration, properties of frequency regulation reserves, control strategies for EVs to support frequency regulation.

UNIT-2 **8L+8T+0P=16 Hours**

ICT SOLUTIONS TO SUPPORT EV DEPLOYMENT :

Introduction, Architecture and model for smart grid & EV, ICT players in smart grid, smart metering, information & communication models, functional and logical models, technology and solution for smart grid: interoperability, communication technologies.

PRACTICES:

- Study of methods required for voltage support and electric vehicle integration.
- Analyze different Information and Communication technologies(ICT) to support EV deployment.
- Development of different smart metering methods.

SKILLS:
✓ F

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the ICT solutions to support EV deployment.	Apply	2	1, 2, 5, 6, 7, 9, 11
2	Describe about vehicle electrification and impact of charging strategies.	Analyze	1	1, 2, 3, 4, 6, 7, 9, 11
3	Describe the influence of EVs on power system.	Analyze	1	1, 3, 6, 7
4	Describe the frequency control and voltage re-serve from EVs.	Analyze	2	1, 3, 6, 7, 9, 11

TEXT BOOKS:

1. SumedhaRajakaruna, FarhadShahnia and Arindam Ghosh, “Plug In Electric Vehicles in Smart Grids-Integration Techniques”, Springer Science + Business Media Singapore Pte Ltd., 2015.
2. Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.

REFERENCE BOOKS:

1. Canbing Li, Yijia Cao, YonghongKuang and Bin Zhou, “Influences of Electric Vehicles on Power System and Key Technologies of Vehicle-to-Grid”, Springer-Verlag Berlin Heidelberg, 2016.
2. Qiuwei Wu, “GRID INTEGRATION OF ELECTRIC VEHICLES IN OPEN ELECTRICITY MARKETS”, John Wiley & Sons, Ltd, 2013.

22EE819 SOFT COMPUTING TECHNIQUES IN ELECTRICAL ENGINEERING

https://www.elprocus.com/soft-computing/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Engineering Mathematics and any programming language.

COURSE DESCRIPTION AND OBJECTIVES:

- Soft computing refers to principle components like fuzzy logic, neural networks and genetic algorithm, which have their roots in Artificial Intelligence.
- Identifying and describing the soft computing techniques and their roles in building intelligent machines.
- Recognize the feasibility of applying a soft computing methodology for a electrical engineering problem.

MODULE-1

UNIT-1 **8L+8T+0P=16 Hours**

INTRODUCTION TO SOFT COMPUTING:

Concept of computing systems. “Soft” computing versus “Hard” computing. Characteristics of Soft computing. Some applications of Soft computing techniques.

UNIT-2 **8L+8T+0P=16 Hours**

ARTIFICIAL NEURAL NETWORKS:

Biological neurons and its working. Simulation of biological neurons to problem solving. Different ANNs architectures. Training techniques for ANNs. Applications of ANNs to solve some real life problems.

PRACTICES:

- Design of Neural network controller for DC motor.
- Design of Neural network controller for Power System Problem.

MODULE–2

UNIT-1 **8L+8T+0P=16 Hours**

FUZZY LOGIC:

Introduction to Fuzzy logic. Fuzzy sets and membership functions. Operations on Fuzzy sets. Fuzzy relations, rules, propositions, implications and inferences. Defuzzification techniques. Fuzzy logic controller design. Some applications of Fuzzy logic.

UNIT-2 **8L+8T+0P=16 Hours**

GENETIC ALGORITHMS:

Concept of “Genetics” and “Evolution” and its application to probabilistic search techniques. Basic GA framework and different GA architectures. GA operators: Encoding, Crossover, Selection, Mutation, etc. Solving single-objective optimization problems using GAs.

PRACTICES:

- Design of Fuzzy Logic controller for DC motor.
- Design of Fuzzy Logic controller for Magnetic suspension system.
- Optimizing PID controller parameters using GA.

SKILLS:

- ✓ *Electrical engineering problem solving using back propagation algorithm.*
- ✓ *Application of fuzzy logic to handle uncertainty and solve engineering problems*
- ✓ *Application of GA to optimization problems*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Solve problems of electrical engineering using back propagation algorithm.	Apply	1	1, 2, 3, 5, 9, 11
2	Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.	Apply	2	1, 2, 3, 5, 9, 11
3	Apply genetic algorithms to combinatorial optimization problems.	Apply	2	1, 2, 3, 5, 9, 11
4	Choose existing software tools to solve real problems using a soft computing approach.	Create	1, 2	1, 2, 3, 5, 6, 9, 11

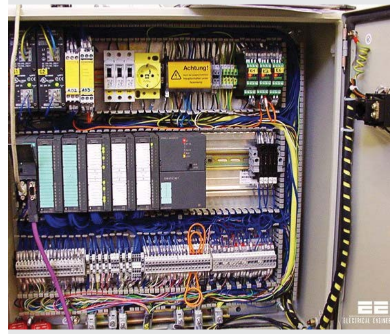
TEXT BOOKS:

1. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India, 2007.
2. Soft Computing, D. K. Pratihar, Narosa, 2008.

REFERENCE BOOKS:

1. Fuzzy Logic: A Pratical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional, 2000.
2. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey, 2010.
3. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.
4. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.
5. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education, 2002.

22EE820 PROGRAMMABLE LOGIC CONTROLLERS



Source: https://electrical-engineering-portal.com/download-center/books-and-guides/automation-control/plc-handbook

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Any introductory programming course

COURSE DESCRIPTION AND OBJECTIVES:

This course covers basic to intermediate theory & applications of programmable logic controllers. PLCs are used in many industrial and commercial processes. It is expected that some industries require skilled people to install, troubleshoot, program & modify PLCs and PLC-controlled systems. The intent of this course is to have students develop the basic-level skills required by industry.

MODULE - 1

UNIT-1 **8L+8T+0P=16 Hours**

INTRODUCTION TO PLCS

- Introduction to Controllers.
- Internal Architecture of PLC.
- PLC Hardware.
- Principles of Operation, Modifying the Operation.
- PLCs versus Computers, PLC Size and Application.

UNIT-2 **8L+8T+0P=16 Hours**

BASICS OF PLC PROGRAMMING

- Processor Memory Organization, Program Scan, PLC Programming Languages.
- Instructions
  - o Relay-Type Instructions.
  - o Instruction Addressing.
  - o Branch Instructions.
  - o Internal Relay Instructions.
  - o Programming Examine If Closed and Examine If Open Instructions.
- Entering the Ladder Diagram.
- Modes of Operation.

PRACTICES:

- Identify the main parts of a PLC and describe their function.
- Describe the basic circuitry and applications for I/O modules and interpret I/O and CPU specifications.
- Define the decimal, binary, octal, and hexadecimal, numbering systems and explain BCD, Gray, and ASCII Codes and be able to convert from one numbering or coding system to another.

SKILLS:

- ✓ Write ladder program for the given expression and also draw ladder logic
- ✓ Apply combinations of counter and timers to control systems.
- ✓ Compare sequential and combination control processes
- ✓ select a PLC for a typical application.

MODULE - 2

UNIT-1 **8L+8T+0P=16 Hours**

LADDER AND FUNCTIONAL BLOCK PROGRAMMING

- Ladder Diagrams.
- Logic Functions.
- Latching.
- Multiple outputs.
- Functional blocks.
- Writing a Ladder Logic Program Directly from a Narrative Description.

UNIT-2 **8L+8T+0P=16 Hours**

PROCESS CONTROL, NETWORK SYSTEMS, AND SCADA

- Types of Processes.
- Structure of Control Systems.
- On/Off Control, PID Control, Motion Control.
- Data Communications.
- Supervisory Control and Data Acquisition (SCADA).

PRACTICES:

- Construct circuits from Boolean expressions and derive Boolean equations for given logic circuits
- Convert relay ladder schematics to ladder logic programs and program instructions that perform logical operations.
- Analyze and interpret typical PLC timer ladder logic programs.
- Apply Analog PLC functions to given process control applications.
- Develop SCADA system for given applications.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Demonstrate knowledge of programmable logic controllers and process control systems.	Apply	1	1, 2, 3, 9, 11
2	Design PLC program using ladder logic.	Apply	1	1, 4, 5, 9, 11
3	Install and troubleshoot the program.	Apply	2	1, 2, 3, 4, 9, 11
4	Design PLC based system for process control.	Analyse	2	1, 2, 3, 9, 11
5	Integrate PLCs into electro-mechanical systems.	Analyse	2	1, 2, 3, 4, 5, 9, 11

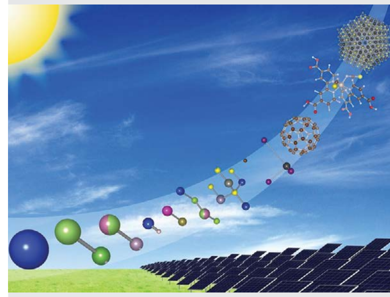
TEXT BOOKS:

1 Frank D. Petruzella – ‘Programmable Logic Controllers’ – McGraw-Hill Education – 2016 – ISBN 13: 9780073373843, 2016.
2 Max Rabiee – ‘Programmable Logic Controllers: Hardware and Programming’ - Goodheart-Wilcox Publisher, 4th edition, ISBN 13: 9781631269349, 2017.

REFERENCE BOOKS:

1 William Bolton, “Programmable Logic Controllers”, Newnes, 6th edition, ISBN 13: 9780128029299, 2015.
2 Luiz Affonso Guedes, “Programmable Logic Controller”, InTech, ISBN 13: 9789537619633, 2010.
3 Gary Dunning, “Introduction to Programmable Logic Controllers: Techniques and Algorithms Inspired by Nature”, Delmar, ISBN 13: 9780766817685, 2008.

22EE821 PV TECHNOLOGIES AND APPLICATIONS



Source : https://news.mit.edu/2015/promise-challenges-solar-photovoltaics-0326

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Physics and Basics of Electrical & Electronics Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed at familiarizing the students with the fundamentals, characteristics, parameters and manufacturing of solar PV cells, series and parallel connection of solar cells, I-V characteristics of a PV module. In this subject students will learn the sun tracking mechanisms, emerging solar cell technologies, battery energy storage systems, design and PV system applications.

MODULE–1

UNIT-1 **12L+8T+0P=20 Hours**

SOLAR CELLS AND PV MODULES:

Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell, Types of solar cells - Monocrystalline, polycrystalline and amorphous silicon cells, Single diode model of solar cell, current equation, I-V characteristics of a PV cell, Parameters of a solar cell, series and shunt resistances, cell efficiency, cell & module efficiencies, fill factor, Series and parallel connection of solar cells, effect of irradiation and temperature, shading and hot spots.

UNIT-2 **4L+8T+0P=12 Hours**

COMPONENTS OF PV SYSTEMS AND BATTERY ENERGY STORAGE:

Components of PV Systems: Classification of PV systems, small system for consumer applications, Hybrid solar PV system, PV system components – charge controller, solar inverter, net metering system.

Battery Energy Storage: Fundamental concept of batteries - Measuring of battery performance, Charging and discharging of a battery, Storage density, Energy density and safety issues; Types of batteries – Lead Acid, Nickel, Cadmium and Lithium ion batteries.

PRACTICES:

- Demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.
- Demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.
- Demonstrate the effect of shading on module output power.
- Demonstrate the working of diode as bypass diode and blocking diode in a PV module.
- Obtain the charging and discharging characteristics of a battery.

MODULE–2

UNIT-1 **12L+10T+0P=22 Hours**

MAXIMUM POWER POINT TRACKING AND DESIGN OF PV SYSTEM:

Maximum Power Point Tracking: Sun tracking – single and dual axis tracking, P-V curves, maximum voltage and current in pv cell, concept of MPPT technique and introduction to algorithms.

Design of PV System: Design of PV system for street lighting, water pumping and residential applications.

SKILLS:

- ✓ *Distinguish between series and parallel combination of PV modules.*
- ✓ *Analyze the effect of shading on module output power.*
- ✓ *Design a solar PV system for a particular application.*
- ✓ *Justify the need of various solar cell technologies.*

UNIT-2 **4L+6T+0P=10 Hours**

PV SYSTEM APPLICATIONS AND EMERGING SOLAR CELL TECHNOLOGIES:

PV System Applications: Building-integrated photovoltaic units, solar lamps, solar street lights, solar water pumps, solar cars, aircraft, space solar power satellites.

Emerging Solar Cell Technologies: Organic solar cells, Dye-synthesized solar cells, GaAs solar cells, Thermo Photovoltaics, Concentrated Photovoltaics.

PRACTICES:

- Workout power flow calculations of standalone PV system of DC load with and without battery.
- Workout power flow calculations of standalone PV system of AC load with and without battery.
- Workout power flow calculations of standalone PV system of DC and AC load with and without battery.
- Review the different emerging solar cell technologies.
- Review the various applications of PV system.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the effect of various parameters on the performance of a solar module.	Analyze	1,2	1, 2, 3, 4, 5, 6, 7, 9, 11
2	Classify the Solar PV systems based on requirements.	Analyze	1,2	1, 2, 4, 6, 7, 9, 11
3	Review the various applications of PV system.	Evaluate	2	1, 2, 4, 5, 6, 7, 9, 11
4	Design a Solar PV system.	Create	2	1, 2, 3, 4, 5, 6, 7. 9. 11, 12

TEXT BOOKS:

1. Chetan Singh Solanki., Solar Photovoltaic: “Fundamentals, Technologies and Application”, PHI Learning Pvt., Ltd., 2009.
2. Jha .A.R, “Solar Cell Technology and Applications”, CRC Press, 2010.

REFERENCES:

1. Chetan Singh Solanki., “Solar Photovoltaic Technology and Systems: A Manual for Technicians” PHI Learning Pvt., Ltd., 2013.
2. Sukhatme .S.P, Nayak .J.K, “Solar Energy”, Tata McGraw Hill Education Private Limited, New Delhi, 2010.
3. John R. Balfour, Michael L. Shaw, Sharlave Jarosek., “Introduction to Photovoltaics”, Jones & Bartlett Publishers, Burlington, 2011.

22EE822 UTILIZATION OF ELECTRICAL ENERGY

Source : https://www.ulektznews.com/2021/05/21/course-in-utilization-of-electrical-energy/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basic Engineering Products.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the fundamentals of electrical drives, illumination, electric heating, welding and traction systems. The objective of the course is to provide an opportunity to study varieties of electric drives and their application to electrical traction systems. It also deals with types of lamps, lightning schemes, light control methods, electrical welding techniques and heating methods employed in industry.

MODULE-1

UNIT-1 **8L+8T+0P=16 Hours**

UTILIZATION AND CONTROL OF ELECTRIC DRIVES:

Introduction, Factors governing selection of electric motors, Type of electric drives - Starting and running characteristics, Speed control and temperature rise; Choice of motor rating, Control devices for industrial motors, Motors for particular services, Load equalization.

UNIT-2 **8L+8T+0P=16 Hours**

ELECTRIC HEATING AND ELECTRIC WELDING:

Introduction, Methods of heat transfer, Classification of electric heating methods - Resistance heating, Induction heating and dielectric heating; Electric welding - Resistance and arc welding; Electric welding equipment, Comparison between A.C. and D.C. welding.

PRACTICES:

- Power supply arrangements.
- Selection of motors for domestic appliances.
- Demonstration about the welding equipment.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

ILLUMINATION ENGINEERING:

Introduction, Terms used in illumination, Laws of illumination, Polar curves, Integrating sphere, Sources of light - Tungsten filament lamps and fluorescent lamps; Basic principles of light control, Types of lighting schemes, Flood lighting.

UNIT-2 **10L+10T+0P=20 Hours**

TRACTION SYSTEMS AND TRAIN MOVEMENT AND ENERGY CONSUMPTION:

Traction Systems: Introduction, Different systems of traction, Systems of electric traction, Systems of track electrification. General features of traction motor, Methods of electric braking.

Train Movement and Energy Consumption: Mechanics of train movement, Typical speed- time curves for different services - Trapezoidal and quadrilateral speed-time curves; Calculations of tractive effort, Power, Specific energy consumption for given run.

SKILLS:

- ✓ *Design simple cooling system for motor, for any given application.*
- ✓ *Design heating element for given application.*
- ✓ *Design lighting scheme for given working area.*
- ✓ *Analyze existing traction systems in nearby railway station.*

PRACTICES:

- Awareness about time switches, street lighting, flood lighting.
- Electrical block diagram of an electric locomotive with description of various equipment and accessories used.
- Types of motors used for electric traction.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Make use of operating principles and characteristics of drives with respect to speed and loading condition.	Apply	1	1,2,9,11
2	Choose different types of heating and welding techniques.	Apply	1	1,2,9,11
3	Examine basic principles of illumination and its measurement.	Analyze	2	1,3,7,9,11
4	Make use of basic principle of electric traction including speed–time curves of different traction services.	Apply	2	1,2,6,9,11
5	Analyze various traction system for braking, acceleration and other related parameters, including demand and side management.	Analyze	2	1,2,9,11

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2. C.L. Wadhwa, “Generation, Distribution and Utilization of electrical Energy”, 3rd edition, New Age International (P) Limited Publishers, 2010.