# NARAYANA ENGINEERING COLLEGE::GUDUR

AUTONOMOUS

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

## COURSE STRUCTURE & SYLLABUS – R23

**Semester –I**

| Course Code | Category | Course Title | Contact Periods Per Week | | | | Credits | *Scheme of Examination Max Marks* | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Internal Marks | External Marks | Total Marks |
| 233PH1001 | BS & H | Engineering Physics | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23MA1001 | BS & H | Linear Algebra & Calculus | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 233ES1003 | ES | Basic Electrical & Electronics Engineering | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23ES1001 | ES | Introduction to Programming | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 233ES1505 | ES | Engineering Graphics | 1 | 0 | 4 | 5 | 3 | 30 | 70 | 100 |
| 233ES1504 | ES | IT Workshop | 0 | 0 | 2 | 2 | 1 | 30 | 70 | 100 |
| 233PH1501 | BS & H | Engineering Physics Lab | 0 | 0 | 2 | 2 | 1 | 30 | 70 | 100 |
| 23ES1502 | ES | Electrical & Electronics Engineering Workshop | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23ES1501 | ES | Computer Programming Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23EX1501 | BS & H | NSS/NCC/Scouts & Guides/Community Service | 0 | 0 | 1 | 1 | 0.5 | - | - | - |
| 23MC8101 | MC | Mandatory Course - Induction Programme | ——— | | | | | | | |
| | | Counselling/Mentoring | 0 | 0 | 1 | 1 | 0 | - | - | - |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | - | - | - |
| | | Activity Point Program | During the Semester | | | | | 20 Points | | |
| | | Total | 13 | 0 | 18 | 31 | 20.5 | 270 | 630 | 900 |

## Semester –II

| Course Code | Category | Course Title | Contact Periods Per Week | | | | Credits | *Scheme of Examination Max Marks* | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Internal Marks | External Marks | Total Marks |
| 23EN1001 | BS & H | Communicative English | 2 | 0 | 0 | 2 | 2 | 30 | 70 | 100 |
| 23CH1001 | BS & H | Chemistry | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23MA1002 | BS & H | Differential Equations & Vector Calculus | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23ES1002 | ES | Basic Civil & Mechanical Engineering | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2001 | PC | Electrical Circuit Analysis – I | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EN1501 | BS & H | Communicative English Lab | 0 | 0 | 2 | 2 | 1 | 30 | 70 | 100 |
| 23CH1501 | BS & H | Chemistry Lab | 0 | 0 | 2 | 2 | 1 | 30 | 70 | 100 |
| 23ES1503 | ES | Engineering Workshop | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23EE2501 | PC | Electrical Circuit Analysis – I Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23LS1501 | BS & H | Health and wellness, Yoga and Sports | 0 | 0 | 1 | 1 | 0.5 | - | - | - |
| | | Counselling/Mentoring | 0 | 0 | 1 | 1 | 0 | - | - | - |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | - | - | - |
| | | Activity Point Program | During the Semester | | | | | 20 Points | | |
| | | Total | 14 | 0 | 14 | 28 | 19.5 | 270 | 630 | 900 |

# NARAYANA ENGINEERING COLLEGE::GUDUR

AUTONOMOUS

## Regulation – R23

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

| S. No | Subjects from department of EEE | Sem/Branch | Category |
|---|---|---|---|
| 1 | Basic Electrical and Electronics Engineering (Part-A) | I-Sem EEE, ECE, ECE-ACT, ECE-VLSI | ES |
| 2 | Electrical and Electronics Engineering Workshop (Part-A) | I-Sem EEE, ECE, ECE-ACT, ECE-VLSI | ES |
| 3 | Electrical Circuit Analysis – I | II- Sem EEE | PC |
| 4 | Electrical Circuit Analysis – I Lab | II- Sem EEE | PC |
| 5 | Network Analysis | II- Sem ECE, ECE-ACT, ECE-VLSI | PC |
| 6 | Network Analysis and Simulation Lab | II- Sem ECE, ECE-ACT, ECE-VLSI | PC |
| 7 | Basic Electrical and Electronics Engineering (Part-A) | II-Sem CSE, CSE-AIML, Mech & CIV | ES |
| 8 | Electrical and Electronics Engineering Workshop (Part-A) | II- Sem CSE, CSE-AIML, Mech & CIV | ES |

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|---|---|---|---|---|---|---|---|---|
| I. B. Tech. | BASIC ELECTRICAL & ELECTRONICS ENGINEERING (Common for all branches) | | | | | | | R23 |
| Semester I | Hours / Week | | | Total Hours | Credits | Max. Marks | | |
| 23ES1003 | L | T | P | | C | CIE | SEE | Total |
| | 3 | 0 | 0 | 24 | 3 | 30 | 70 | 100 |

**Pre-requisite:** NIL

**Course Objectives:**

**Course Outcomes:** At the end of this course students will demonstrate the ability to

| | |
|---|---|
| **CO1** | Remember the fundamental laws, operating principles of motors, generators, MC and MI instruments. |
| **CO2** | Understand the problem solving concepts associated to AC and DC circuits, construction and operation of AC and DC machines, measuring instruments; different power generation mechanisms, Electricity billing concept and important safety measures related to electrical operations. |
| **CO3** | Apply mathematical tools and fundamental concepts to derive various equations related to machines, circuits and measuring instruments; electricity bill calculations and layout representation of electrical power systems. |

**CO-PO Mapping**

| Cos | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 3 | | | | | | | | | | 2 | 3 |
| CO2 | 3 | 3 | 3 | | | | | | | | | | 2 | 3 |
| CO3 | 3 | 3 | 3 | 2 | | | | | | | | | 3 | 3 |

**1 - Low, 2 - Medium, 3 - High**

**Course Content**

**PART A: BASIC ELECTRICAL ENGINEERING**

| Module-1 | DC & AC Circuits | Hours: 10 |
|---|---|---|

**DC Circuits:** Electrical circuit elements (R, L and C), Ohm's Law and its limitations, KCL & KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

**AC Circuits:** A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of Impedance, Active power, reactive power and apparent power, Concept of power factor (Simple Numerical problems).

**At the end of the Module – 1, Students will be able to:**

1. Explain the solution techniques to solve the DC & AC Circuits.

| Module-2 | Machines and Measuring Instruments | Hours: 07 |
|---|---|---|

**Machines:** Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

**Measuring Instruments:** Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone bridge.

**At the end of the Module – 2, Students will be able to:**

1. Explain the working of different types of motors.

2. Explain the usage of different types of Instruments.

| **Module-3** | **Energy Resources, Electricity Bill & Safety Measures** | **Hours: 07** |
|---|---|---|

**Energy Resources:** Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Nuclear, Solar & Wind power generation.

**Electricity bill:** Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of "unit" used for consumption of electrical energy, two-part electricity tariff, calculation of electricity bill for domestic consumers.

**Equipment Safety Measures:** Working principle of Fuse and Miniature circuit breaker(MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

**At the end of the Module – 3, Students will be able to:**

1. Understand the different resources available in nature.
2. Understand the billing procedure of their home.
3. Explain the different safety rules against the electrical shock.

| **Total Hours:** | **24** |
|---|---|

**Content beyond Syllabus:**

Usage of different measurement equipments in electrical system.

**Self Study:**

| S. No. | Topic | COs | Reference |
|---|---|---|---|
| 1 | Concept of Impedance, Active power, reactive power and apparent power | **CO1** | https://www.allaboutcircuits.com/textbook/alternating-current/chpt-11/true-reactive-and-apparent-power/#:~:text=As%20a%20rule%2C%20true%20power,circuit's%20total%20impedance%20(Z). |
| 2 | Applications of electrical machines | **CO2** | https://en.wikipedia.org/wiki/Electric_machine#:~:text=Electric%20motors%20are%20found%20in,AC%20motors%20and%20DC%20motors. |
| 3 | Earthing and its types | **CO3** | https://www.electricaltechnology.org/2015/05/earthing-and-electrical-grounding-types-of-earthing.html |

**Text Book(s):**

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, FirstEdition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition.

**Reference Book(s):**

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019,Fourth Edition
2. Principles of Power Systems, V.K. Mehtha, S.Chand Technical Publishers, 2020
3. Basic Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford UniversityPress, 2017
4. Basic Electrical and Electronics Engineering, S. K. Bhatacharya, Person Publications,2018, Second Edition.

**Online Resources / Web References:**

1. https://nptel.ac.in/courses/108105053
2. https://nptel.ac.in/courses/108108076

| NARAYANA ENGINEERING COLLEGE :: GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I. B. Tech. | ELECTRICAL & ELECTRONICS ENGINEERING WORKSHOP (Common for all branches) | | | | | | | R23 |
| Semester I | Hours / Week | | | Total Hours | Credits | Max. Marks | | |
| 23ES1502 | L | T | P | | C | CIE | SEE | Total |
| | 0 | 0 | 3 | 24 | 1.5 | 30 | 70 | 100 |

**Pre-requisite:** NIL

**Course Objectives:**

**Course Outcomes:** At the end of this course students will demonstrate the ability to

| | |
|---|---|
| **CO1** | Understand the Electrical circuit design concept; measurement of resistance, power, power factor; concept of wiring and operation of Electrical Machines and Transformer. |
| **CO2** | Apply the theoretical concepts and operating principles to derive mathematical models for circuits, Electrical machines and measuring instruments; calculations for the measurement of resistance, power and power factor. |
| **CO3** | Apply the theoretical concepts to obtain calculations for the measurement of resistance, power and power factor. |

**CO-PO Mapping**

| COs | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 1 | | | | | | | | | | 2 | 3 |
| CO2 | 2 | 2 | 2 | | | | | | | | | | 2 | 3 |
| CO3 | 3 | 2 | 2 | | | | | | | | | | 2 | 3 |

**1 - Low, 2 - Medium, 3 - High**

**Course Content**

**(PART A: ELECTRICAL ENGINEERING LAB)**

**List of experiments:**

1. Verification of KCL and KVL
2. Verification of Superposition theorem
3. Measurement of Resistance using Wheat stone bridge
4. Magnetization Characteristics of DC shunt Generator
5. Measurement of Power and Power factor using Single-phase wattmeter
6. Measurement of Earth Resistance using Megger
7. Calculation of Electrical Energy for Domestic Premises

**Note:** Minimum Six Experiments to be performed.

**Text Book(s):**

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, FirstEdition.

**Reference Book(s):**

1. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
2. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition.

**Online Resources / Web References:**

https://www.roboversity.com/workshops

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|---|---|---|---|---|---|---|---|---|
| I. B. Tech. | ELECTRICAL CIRCUIT ANALYSIS - I | | | | | | | R23 |
| Semester I | Hours / Week | | | Total Hours | Credits | Max. Marks | | |
| 23EE2001 | L | T | P | | C | CIE | SEE | Total |
| | 3 | 0 | 0 | 45 | 3 | 30 | 70 | 100 |

**Pre-requisite:** NIL

**Course Objectives:**

To develop an understanding of the fundamental laws, elements of electrical circuits and to apply circuit analysis to DC and AC circuits.

**Course Outcomes:** At the end of this course students will demonstrate the ability to

| | |
|---|---|
| **CO1** | Remembering the basic electrical elements and different fundamental laws. |
| **CO2** | Understand the network reduction techniques, transformations, concept of self- inductance and mutual inductance, phasor diagrams, resonance and network theorems. |
| **CO3** | Apply the concepts to obtain various mathematical and graphical representations. |
| **CO4** | Analyse nodal and mesh networks, series and parallel circuits, steady state response,different circuit topologies (with R, L and C components). |
| **CO5** | Evaluation of Network theorems, electrical, magnetic and single-phase circuits. |

**CO-PO Mapping**

| COs | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 1 | | | | | | | | | | 3 | 1 |
| CO2 | 3 | 3 | 3 | | | | | | | | | | 2 | 1 |
| CO3 | 3 | 3 | 3 | | | | | | | | | | 3 | 3 |
| CO4 | 3 | 3 | 3 | | | | | | | | | | 2 | 3 |
| CO5 | 3 | 3 | 2 | | | | | | | | | | 2 | 3 |

**1 - Low, 2 - Medium, 3 - High**

**Course Content**

| Module-1 | INTRODUCTION TO ELECTRICAL CIRCUITS | Hours: 10 |
|---|---|---|

Basic Concepts of passive elements of R, L, C and their V-I relations, Sources (dependent and independent), Kirchoff's laws, Network reduction techniques (series, parallel, series - parallel, star-to-delta and delta-to-star transformation), source transformation technique, nodal analysis and mesh analysis to DC networks with dependent and independent voltage and current sources, node and mesh analysis.

**At the end of the Module – 1, Students will be able to:**

1. Find the series and parallel connections in a circuit.
2. Apply various techniques to analyze an electric circuit.
3. Find the behaviour of an electrical circuit.

| Module-2 | MAGNETIC CIRCUITS | Hours: 10 |
|---|---|---|

Basic definition of MMF, flux and reluctance, analogy between electrical and magnetic circuits,Faraday's laws of electromagnetic induction – concept of self and mutual inductance, Dot convention – coefficient of coupling and composite magnetic circuit, analysis of series and parallel magnetic circuits.

**At the end of the Module – 2, Students will be able to:**

1. Explain the laws of electromagnetic induction.
2. Explain the dot convention technique.

3. Explain the self Inductance and mutual Inductance.

| Module-3 | SINGLE PHASE CIRCUITS | Hours: 8 |
|---|---|---|

Characteristics of periodic functions, Average value, R.M.S. value, form factor, representation of a sine function, concept of phasor, phasor diagrams, node and mesh analysis. Steady state analysis of R, L and C circuits to sinusoidal excitations-response of pure resistance, inductance,capacitance, series RL circuit, series RC circuit, series RLC circuit, parallel RL circuit, parallelRC circuit.

**At the end of the Module – 3, Students will be able to:**

1. Understand the advantages of single phase AC system.
2. Explain the complex and polar forms representation.
3. Find the AC circuits in order to determine the voltage, current and power for the given problem.

| Module-4 | RESONANCE AND LOCUS DIAGRAMS | Hours: 10 |
|---|---|---|

Series Resonance: Characteristics of a series resonant circuit, Q-factor, selectivity and bandwidth, expression for half power frequencies; Parallel resonance: Q-factor, selectivity and bandwidth; Locus diagram: RL, RC, RLC with R, L and C variables.

**At the end of the Module – 4, Students will be able to:**

1. Explain AC circuits along with resonance and locus diagrams.
2. Understand the effect of resonance on series and parallel resonance circuits.
3. Explain the frequency response for a resonant circuits.

| Module-5 | NETWORK THEOREMS (DC & AC EXCITATIONS) | Hours: 10 |
|---|---|---|

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfertheorem, Reciprocity theorem, Millman's theorem and compensation theorem

**At the end of the Module – 5, Students will be able to:**

1. Understand the way of approaching to solve for a given network.
2. Solve theorems for finding the solutions of network problem.
3. Explain the application of network theorems.

| Total Hours: | 48 |
|---|---|

**Content beyond Syllabus:**

1. Three Phase circuits and its Importance in Electrical Engineering.
2. Real time applications of network theorems.

**Self Study:**

| S. No. | Topic | CO | Reference |
|---|---|---|---|
| 1 | Introduction to the electrical& magnetic circuits | CO1 | https://nptel.ac.in/courses/117/106/117106108/ |
| 2 | Single phase AC circuit | CO2 | https://nptel.ac.in/courses/108/105/108105053/ |
| 3 | Locus diagram and resonance | CO3 | https://nptel.ac.in/courses/108/105/108105112/ |
| 4 | Analysis of electrical circuitand Graph theory | CO4 | https://nptel.ac.in/courses/108/105/108105159/ |
| 5 | Network theorem | CO5 | https://nptel.ac.in/courses/117/106/117106108/ |

**Text Book(s):**

1. Engineering Circuits Analysis, Jack Kemmerly, William Hayt and Steven Durbin, Tata Mc Graw Hill Education, 2005, sixth edition.

2. Network Analysis, M. E. Van Valkenburg, Pearson Education, 2019, Revised Third Edition.

**Reference Book(s):**

1. Fundamentals of Electrical Circuits, Charles K. Alexander and Mathew N.O. Sadiku, Mc Graw Hill Education (India), 2013, Fifth Edition

2. Electric Circuits (Schaum's outline Series), Mahmood Nahvi, Joseph Edminister, and K. Rao, Mc Graw Hill Education, 2017, Fifth Edition.

3. Electric Circuits, David A. Bell, Oxford University Press, 2009, Seventh Edition.

4. Introductory Circuit Analysis, Robert L Boylestad, Pearson Publications, 2023, Fourteenth Edition.

5. Circuit Theory: Analysis and Synthesis, A. Chakrabarti, Dhanpat Rai & Co., 2018, Seventh Revised Edition.

**Online Resources / Web References:**

1. https://onlinecourses.nptel.ac.in/noc23_ee81/preview
2. https://nptel.ac.in/courses/108104139
3. https://nptel.ac.in/courses/108106172
4. https://nptel.ac.in/courses/117106108

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|---|---|---|---|---|---|---|---|---|
| I. B. Tech. | ELECTRICAL CIRCUIT AANALYSIS – I LABORATORY | | | | | | | R23 |
| Semester I | Hours / Week | | | Total Hours | Credits | Max. Marks | | |
| 23EE2501 | L | T | P | | C | CIE | SEE | Total |
| | 0 | 0 | 3 | 48 | 1.5 | 30 | 70 | 100 |

**Pre-requisite:** NIL

**Course Objectives:**

To impart hands on experience in verification of circuit laws and theorems, measurement of circuit parameters, study of circuit characteristics. It also gives practical exposure to the usage of different circuits with different conditions.

**Course Outcomes:** At the end of this course students will demonstrate the ability to

| | |
|---|---|
| **CO1** | Understand the concepts of network theorems, node and mesh networks, series and parallel resonance and Locus diagrams. |
| **CO2** | Apply various theorems to compare practical results obtained with theoreticalcalculations. |
| **CO3** | Determine self, mutual inductances and coefficient of coupling values, parameters of choke coil. |
| **CO4** | Analyze different circuit characteristics with the help of fundamental laws and various configurations. |
| **CO5** | Create locus diagrams of RL, RC series circuits and examine series and parallelresonance. |

**CO-PO Mapping**

| COs | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO5 | 2 | 2 | 1 | | | | 1 | | | | | | 2 | 3 |

**1 - Low, 2 - Medium, 3 - High**

**Course Content**

**List of Experiments:**

1. Verification of Kirchhoff's circuit laws.
2. Verification of node and mesh analysis.
3. Verification of network reduction techniques.
4. Determination of cold and hot resistance of an electric lamp
5. Determination of Parameters of a choke coil.
6. Determination of self, mutual inductances, and coefficient of coupling
7. Series and parallel resonance
8. Locus diagrams of R-L (L Variable) and R-C (C Variable) series circuits
9. Verification of Superposition theorem
10. Verification of Thevenin’s and Norton’s Theorems
11. Verification of Maximum power transfer theorem
12. Verification of Compensation theorem
13. Verification of Reciprocity and Millman’s Theorems

**Virtual Labs:**

1. Parallel RC Circuits
2. Parallel LC Circuits
3. Thevenin's theorem
4. Series RL Circuits
5. Norton's Theorem
6. Series LCR Circuit

**Text Book(s):**

1. Engineering Circuits Analysis, Jack Kemmerly, William Hayt and Steven Durbin, Tata Mc Graw Hill Education, 2005, sixth edition.

**Reference Book(s):**

1. Network Analysis, M. E. Van Valkenburg, Pearson Education, 2019, Revised Third Edition.

**Online Resources / Web References:**

1. https://www.ee.iitkgp.ac.in/
2. http://www.vlab.co.in/lab_ready_for_use.php
3. http://vlab.amrita.edu/?sub=1&brch=75

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Thevinins andnortons | CO1 | **https://www.youtube.com/watch?v=7JfoDFk61o8** |
| 2 | Series Resonance in RLC Circuit | CO2 | **https://www.youtube.com/watch?v=YLGrugmDvc0** |
| 3 | Phasor Diagram of RL, RC and RLC Circuits | CO3 | **https://www.youtube.com/watch?v=HaFrY0qQ-NU** |

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|---|---|---|---|---|---|---|---|---|
| I. B. Tech. | NETWORK ANALYSIS | | | | | | | R23 |
| Semester I | Hours / Week | | | Total Hours | Credits | Max. Marks | | |
| 23EE2002 | L | T | P | | C | CIE | SEE | Total |
| | 3 | 0 | 0 | 48 | 3 | 30 | 70 | 100 |

**Pre-requisite:** NIL

**Course Objectives:**

**Course Outcomes:** At the end of this course students will demonstrate the ability to

| | |
|---|---|
| **CO1** | Understand basic electrical circuits with nodal and mesh analysis. |
| **CO2** | Analyse the circuit using network simplification theorems. |
| **CO3** | Find Transient response and Steady state response of a network. |
| **CO4** | Analyse electrical networks in the Laplace domain. |
| **CO5** | Compute the parameters of a two-port network. |

**CO-PO Mapping**

| COs | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 1 | | | | | | | | | | 3 | 1 |
| CO2 | 3 | 3 | 3 | | | | | | | | | | 2 | 1 |
| CO3 | 3 | 3 | 3 | | | | | | | | | | 3 | 3 |
| CO4 | 3 | 3 | 3 | | | | | | | | | | 2 | 3 |
| CO5 | 3 | 3 | 2 | | | | | | | | | | 2 | 3 |

**1 - Low, 2 - Medium, 3 - High**

**Course Content**

| Module-1 | Sources and Network Theorems | Hours: 10 |
|---|---|---|

Types of circuit components, Types of Sources and Source Transformations, Mesh analysis and Nodal analysis, problem solving with resistances only including dependent sources also. Principal of Duality with examples.

**Network Theorems:** Thevenin's, Norton's, Milliman's, Reciprocity, Compensation, Substitution, Superposition, Max Power Transfer, Tellegens - problem solving using dependentsources also.

**At the end of the Module – 1, Students will be able to:**

1. Understand the solving of network with Mesh and Node analysis.
2. Explain about theorems and their applications.

| Module-2 | Transients Analysis and Laplace Transform | Hours: 10 |
|---|---|---|

**Transients:** First order differential equations, Definition of time constants, R-L circuit, R-C circuit with DC excitation, evaluating initial conditions procedure, second order differential equations, homogeneous, non-homogenous, problem-solving using R-L-C elements with DC excitation and AC excitation, Response as related to s-plane rotation of roots.

**Laplace transform:** Introduction, Laplace transformation, basic theorems, problem solving using Laplace transform, partial fraction expansion, Heaviside's expansions, problem solving using Laplace transform.

**At the end of the Module – 2, Students will be able to:**

1. Illustrate the DC circuit and their outputs with different types of responses.
2. Illustrate the usage of Laplace transform in electrical circuit analysis.

| Module-3 | Steady State Analysis of AC Circuits | Hours: 8 |
|---|---|---|

Steady State Analysis of A.C Circuits: Impedance concept, phase angle, series R-L, R-C, R-L-C circuits problem solving. Complex impedance and phasor notation for R-L, R-C, R-L-C problem solving using

mesh and nodal analysis, Star-Delta conversion, problem solving using Laplace transforms also.

**At the end of the Module – 3, Students will be able to:**

1. Explain the phasor diagram and its usage to solve the problems in AC circuits or systems.

| **Module-4** | **Resonance and Coupled Circuits** | **Hours: 10** |
|---|---|---|

**Resonance:** Introduction, Definition of Q, Series resonance, Bandwidth of series resonance, Parallel resonance, general case-resistance present in both branches, anti-resonance at all frequencies.

**Coupled Circuits:** Coupled Circuits: Self-inductance, Mutual inductance, Coefficient of coupling, analysis of coupled circuits, Natural current, Dot rule of coupled circuits, conductively coupled equivalent circuits- problem solving.

**At the end of the Module – 4, Students will be able to:**

1. Explain AC circuits along with resonance and locus diagrams.
2. Understand the effect of resonance on series and parallel resonance circuits.
3. Explain the frequency response for a resonant circuits.

| **Module-5** | **Two-port Networks and Filters** | **Hours: 10** |
|---|---|---|

**Two-port Networks:** Relationship of two port networks, Z-parameters, Y-parameters, Transmission line parameters, h- parameters, Relationships Between parameter Sets, Parallel & series connection of two port networks, cascading of two port networks, problem solving using dependent sources also.

**Image and iterative impedances:** Image and iterative transfer constants. Insertion loss. Attenuators and pads. Lattice network and its parameters. Impedance matching networks.

**At the end of the Module – 5, Students will be able to:**

1. Explain bout the analysis of electrical circuits with two ports.
2. Understand the operation of filters.

| | **Total Hours:** | **48** |
|---|---|---|

**Content beyond Syllabus:**

Transient Analysis of AC Circuits.

**Self Study:**

| **S. No.** | **Topic** | **CO** | **Reference** |
|---|---|---|---|
| 1 | Introduction to the electrical& magnetic circuits | **CO1** | https://nptel.ac.in/courses/117/106/117106108/ |
| 2 | Single phase AC circuit | **CO2** | https://nptel.ac.in/courses/108/105/108105053/ |
| 3 | Analysis of electrical circuitand Graph theory | **CO4** | https://nptel.ac.in/courses/108/105/108105159/ |
| 4 | Network theorem | **CO5** | https://nptel.ac.in/courses/117/106/117106108/ |

**Text Book(s):**

1. Network Analysis – ME Van Valkenburg, Prentice Hall of India, revised 3rd Edition,2019.
2. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Jamie Phillips,Steven M. Durbin, 9th Edition 2020.
3. Network lines and Fields by John. D. Ryder 2nd Edition, PHI.

**Reference Book(s):**

1. D. Roy Choudhury, Networks and Systems, New Age International Publications, 2013.
2. Joseph Edminister and Mahmood Nahvi, Electric Circuits, Schaum's Outline Series, 7th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017

| |
|---|
| 3. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N. O. Sadiku, McGraw-Hill Education. |
| **Online Resources / Web References:**<br>1. https://onlinecourses.nptel.ac.in/noc23_ee81/preview<br>2. https://nptel.ac.in/courses/108104139<br>3. https://nptel.ac.in/courses/108106172<br>4. https://nptel.ac.in/courses/117106108 |

| NARAYANA ENGINEERING COLLEGE :: GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I. B. Tech. | NETWORK ANALYSIS LABORATORY | | | | | | | R23 |
| Semester I | Hours / Week | | | Total Hours | Credits | Max. Marks | | |
| 23EE2502 | L | T | P | | C | CIE | SEE | Total |
| | 0 | 0 | 3 | 48 | 1.5 | 30 | 70 | 100 |

**Pre-requisite:** NIL

**Course Objectives:**

**Course Outcomes:**

| | |
|---|---|
| **CO1** | Verify Kirchoff's laws and network theorems. |
| **CO2** | Measure time constants of RL & RC circuits. |
| **CO3** | Analyze behavior of RLC circuit for different cases. |
| **CO4** | Design resonant circuit for given specifications. |
| **CO5** | Characterize and model the network in terms of all network parameters. |

**CO-PO Mapping**

| COs | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 1 | 1 | | 1 | 2 | | 1 | | 2 | 2 | 2 |
| CO5 | 2 | 2 | 1 | | 1 | | 1 | | | | | | 2 | 3 |

**1 - Low, 2 - Medium, 3 - High**

**Course Content**

The experiments need to be simulated using software and the same need to beverified using the hardware.

1. Study of components of a circuit and Verification of KCL and KVL.
2. Verification of mesh and nodal analysis for AC circuits
3. Verification of Superposition, Thevenin's & Norton theorems for AC circuits
4. Verification of maximum power transfer theorem for AC circuits
5. Verification of Tellegen's theorem for two networks of the same topology.
6. Study of DC transients in RL, RC and RLC circuits
7. To study frequency response of various $1^{st}$ order RL & RC networks
8. To study the transient and steady state response of a $2^{nd}$ order circuit byvarying its various parameters and studying their effects on responses
9. Find the Q Factor and Bandwidth of a Series and Parallel Resonance circuit.
10. Determination of open circuit (Z) and short circuit (Y) parameters
11. Determination of hybrid (H) and transmission (ABCD) parameters
12. To measure two port parameters of a twin-T network and study its frequency response.

**Hardware Requirements:**

Regulated Power supplies, Analog/Digital Function Generators, Digital Multimeters, Decade Resistance Boxes/Rheostats, Decade Capacitance Boxes, Ammeters (Analog or Digital), Voltmeters (Analog or Digital), Active & Passive Electronic Components.

**Software requirements:**

Multisim/ Pspice/Equivalent simulation software tool, Computer Systems with required

specifications.

**Text Book(s):**

1. Network Analysis – ME Van Valkenburg, Prentice Hall of India, revised 3rdEdition, 2019.

**Reference Book(s):**

1. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, JamiePhillips, Steven M. Durbin, 9th Edition 2020.

**Online Resources / Web References:**

1. https://www.ee.iitkgp.ac.in/
2. http://www.vlab.co.in/lab_ready_for_use.php
3. http://vlab.amrita.edu/?sub=1&brch=75

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Thevinins andnortons | CO1 | **https://www.youtube.com/watch?v=7JfoDFk61o8** |
| 2 | Series Resonance in RLC Circuit | CO2 | **https://www.youtube.com/watch?v=YLGrugmDvc0** |
| 3 | Phasor Diagram of RL, RC and RLC Circuits | CO3 | **https://www.youtube.com/watch?v=HaFrY0qQ-NU** |

NARAYANA ENGINEERING COLLEGE
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Est : 2001

SEMESTER III (2nd Year, 1st Semester)

| Course Code | Category | Course Title | Contact Periods perweek | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 23MA1004 | BS | Complex Variables & Numerical Methods | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EN1002 | HSMC | Universal Human Values-Understanding Harmony | 2 | 1 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23ES1004 | ES | Electromagnetic Field Theory | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2003 | PC | Electrical Circuit Analysis-II | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2004 | PC | DC Machines & Transformers | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23SC6103 | SEC | Data Structures | 0 | 1 | 2 | 3 | 2 | 30 | 70 | 100 |
| 23EE2503 | PC | Electrical Circuit Analysis-II and Simulation Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23EE2504 | PC | DC Machines & Transformers Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23MC8102 | AC | Environmental Science | 2 | 0 | 0 | 2 | 0 | -- | -- | -- |
| | | Counseling / Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **16** | **2** | **11** | **29** | **20** | **240** | **560** | **800** |

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|---|---|---|---|---|---|---|---|---|
| II-B.Tech | ELECTROMAGNETIC FIELD THEORY | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To review the fundamentals of the different coordinate systems, vector algebra and calculus
2. To teach the basic laws of electromagnetism
3. To learn to compute and visualize the electrostatic and magnetostatic fields for simple configurations
4. To analyse the time varying electric and magnetic fields and to understand Maxwell's equations
5. To understand the propagation of electromagnetic waves through different media

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

| | |
|---|---|
| **CO 1** | Remember the concepts of vector algebra, vector calculus, various fundamental laws, self and mutual inductance. (BL1) |
| **CO 2** | Understand the concepts of electrostatics, conductors, dielectrics, capacitance, magneto statics, magnetic fields, time varying fields, self and mutual inductances. (BL2) |
| **CO 3** | Apply vector calculus, Coulomb's law, Gauss's law, Ohm's law in point form, Biot- Savart's law, Ampere's circuital law, Maxwell's third equation, self and mutual inductances, Faraday's laws, Maxwell's fourth equation, Poynting theorem to solve various numerical problems. (BL3) |
| **CO 4** | Analyze vector calculus, electrostatic fields, behavior of conductor in electric filed, Biot-Savart's law and its applications. (BL4) |
| **CO 5** | Analyze magnetic force, moving charges in a magnetic field, self-inductance of different cables, mutual inductance between different wires and time varying fields. (BL4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO3 | 3 | 3 | 1 | 1 | | | | | | | | | 2 | 1 |
| CO4 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO5 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Vector Analysis & Electrostatics

**Vector Algebra:** Scalars and Vectors, Unit vector, Vector addition and subtraction, Position and distance vectors, Vector multiplication, Components of a vector.

**Coordinate Systems:** Rectangular, Cylindrical and Spherical coordinate systems.

**Vector Calculus:** Differential length, Area and Volume. Del operator, Gradient of a scalar, Divergence of a vector and Divergence theorem (definition only). Curl of a vector and Stoke's

theorem (definition only), Laplacian of a scalar.

**Electrostatics:**

Coulomb's law and Electric field intensity (EFI) – EFI due to Continuous charge distributions (line and surface charge), Electric flux density, Gauss's law (Maxwell's first equation, $\nabla.\vec{D} = \rho_v$), Applications of Gauss's law, Electric Potential, Work done in moving a point charge in an electrostatic field (second Maxwell's equation for static electric fields, $\nabla \times \vec{E} = 0$), Potential gradient, Laplace's and Poison's equations.

**MODULE -2: Conductors – Dielectrics and Capacitance**

Behavior of conductor in Electric field, Electric dipole and dipole moment – Potential and EFI due to an electric dipole, Torque on an Electric dipole placed in an electric field, Current density-conduction and convection current densities, Ohm's law in point form, Behavior of conductors in an electric field, Polarization, dielectric constant and strength, Continuity equation and relaxation time, Boundary conditions between conductor to dielectric, dielectric to dielectric and conductor to free space, Capacitance of parallel plate, coaxial and spherical capacitors, Energy stored and density in a static electric field, Coupled and decoupled capacitors.

**MODULE-3: Magneto statics, Ampere's Law and Force in magnetic fields**

Biot-Savart's law and its applications viz. Straight current carrying filament, circular, square, rectangle and solenoid current carrying wire – Magnetic flux density and Maxwell's second Equation ($\nabla.\vec{B} = 0$), Ampere's circuital law and its applications viz. MFI due to an infinite sheet, long filament, solenoid, toroidal current carrying conductor, point form of Ampere's circuital law, Maxwell's third equation ($\nabla \times \vec{H} = \vec{J}$).

Magnetic force, moving charges in a magnetic field – Lorentz force equation, force on a current element in a magnetic field, force on a straight and a long current carrying conductor in a magnetic field, force between two straight long and parallel current carrying conductors, Magnetic dipole, Magnetic torque, and moment.

**MODULE-4: Self and mutual inductance**

Self and mutual inductance – determination of self-inductance of a solenoid, toroid, coaxial cable and mutual inductance between a straight long wire and a square loop wire in the same plane – Energy stored and energy density in a magnetic field.

**MODULE-5: Time Varying Fields**

Faraday's laws of electromagnetic induction, Maxwell's fourth equation($\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$), integral and point forms of Maxwell's equations, statically and dynamically induced EMF, Displacement current, Modification of Maxwell's equations for time varying fields, Poynting theorem and Poynting vector.

| | |
|---|---|
| **Total hours:** | **54 hours** |

**Term work:**

Design of solenoid and thoroid.

**Content beyond syllabus:**

Electric power transmission

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| | 1 | Gauss's law and its applications | CO1 | https://www.youtube.com/watch?v=M0GInI0vNh8 |
| | 2 | Poisson's and Laplace's equations | CO2 | https://www.youtube.com/watch?v=I-lKnLnnbY4 |
| | 3 | Biot– Savart's Law | CO3 | https://www.youtube.com/watch?v=X9mYh8aG2AQ |
| | 4 | Neumann's formula | CO4 | https://www.youtube.com/watch?v=iVANETIf3cM |
| | 5 | Displacement current | CO5 | https://www.youtube.com/watch?v=77PZPBXMl1w |

**Text Book(s):**

1. Mathew N. O. Sadiku, S.V.Kulkarni, 'Principles of Electromagnetics', 6th Edition, Oxford University Press, 2015, Asian Edition
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', Tata McGraw Hill ,8th Revised edition, 2014
3. "Elements of Electromagnetics" by Matthew N O Sadiku, Oxford Publications, 7th edition, 2018.
4. "Engineering Electromagnetics" by William H. Hayt& John. A. Buck Mc. Graw-Hill, 7th Editon.2006.

**Reference Book(s):**

1. Bhag Singh Guru and Huseyin R. Hiziroglu "Electromagnetic field theory fundamentals", Cambridge University Press; Second Revised Edition, 2009.
2. Ashutosh Pramanik, 'Electromagnetism – Theory and Applications', PHI Learning Private Limited, New Delhi, Second Edition-2009
3. Inan U. S. and A. S. Inan, Engineering Electromagnetics, Pearson Education, 2010.
4. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), Tata McGraw Hill, 2010
5. "Introduction to Electro Dynamics" by D J Griffiths, Prentice-Hall of India Pvt. Ltd, 2nd edition.
6. "Electromagnetic Field Theory" by Yaduvir Singh, Pearson India, 1st edition, 2011.
7. "Fundamentals of Engineering Electromagnetics" by Sunil Bhooshan, Oxford University Press, 2012.

**Online Resources:**

1. http://alumni.media.mit.edu/~aggelos/papers/EM_Hayt_6th.pdf
2. https://nptel.ac.in/courses/108/106/108106073/

**Web Resources:**

1. https://www.youtube.com/watch?v=pGdr9WLto4A&list=PLl6m4jcR_DbOx6s2toprJQx1MORqPa9rG
2. https://www.youtube.com/watch?v=G5P6dInMTFg&list=PLuv3GM6-gsE3-hVNaw-YEb7EeY5XVPZdz
3. https://archive.nptel.ac.in/courses/108/106/108106073/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | Electrical Circuit Analysis – II | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To know the analysis of three phase balanced and unbalanced circuits and to measure active and reactive powers in three phase circuits.
2. Knowing how to determine the transient response of R-L, R-C, R-L-C series circuits for D.C and A.C excitations.
3. To introduce the various two-port networks parameters for a given circuit.
4. To evaluation of poles and zeros of a given transfer function.
5. To study the different types of filters

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

| | |
|---|---|
| **CO 1** | Remember the concepts of Laplace transforms, formulation of various circuit topologies (R, L and C components) and basic filters. (BL1) |
| **CO 2** | Understand three phase balanced and unbalanced circuits, different circuit configurations and it's mathematical modeling, network parameters and various filters. (BL2) |
| **CO 3** | Apply Laplace transforms to solve various electrical network topologies and filter design concepts. (BL3) |
| **CO 4** | Analyze three phase circuits, transient response of various network topologies, electric circuits with periodic excitations and filter characteristics. (BL4) |
| **CO 5** | Design suitable electrical circuits and various filters for different applications. (BL5) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 3 | 3 | 2 | | | | | | | | | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 2 | | | | | | | | | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | | | | | | | | | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | | | | | | | | | 1 | 2 |
| **CO5** | 2 | 2 | 3 | 2 | | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Analysis of three phase balanced & unbalanced circuits

**Analysis of three phase balanced circuits:**

Phase sequence, star and delta connection of sources and loads, relation between line and phase quantities, analysis of balanced three phase circuits, measurement of active and reactive power.

**Analysis of three phase unbalanced circuits:**

Loop method, Star-Delta transformation technique, two-wattmeter method for measurement of three phase power.

| MODULE-2: Laplace Transform and Transient Analysis | |
|---|---|
| **Laplace transforms** – Definition and Laplace transforms of standard functions– Shifting theorem – Transforms of derivatives and integrals,Inverse Laplace transforms and applications. **Transient Analysis:** Transient response of R-L, R-C and R-L-C circuits (Series and parallel combinations) for D.C. and sinusoidal excitations – Initial conditions - Solution using differential equation approach and Laplace transform approach. | |
| **MODULE-3: Network Parameters** | |
| Impedance parameters, Admittance parameters, Hybrid parameters, Transmission (ABCD) parameters, conversion of Parameters from one form to other, Conditions for Reciprocity and Symmetry, Interconnection of Two Port networks in Series, Parallel and Cascaded configurations- problems. | |
| **MODULE-4: Analysis of Electric Circuits with Periodic Excitation** | |
| Fourier series and evaluation of Fourier coefficients, Trigonometric and complex Fourier series for periodic waveforms, Application to Electrical Systems – Effective value and average value of non-sinusoidal periodic waveforms, power factor, effect of harmonics | |
| **MODULE-5: Filters** | |
| Classification of filters-Low pass, High pass, Band pass and Band Elimination filters, Constant-k filters -Low pass and High Pass, Design of Filters. | |
| **Total hours:** | **54 hours** |

**Term work:**

Must be submit at least two assignments.

**Content beyond syllabus:**

1.Locus diagram and Electro magnetism

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Analysis of Three Phase balanced circuits | CO1 | https://www.youtube.com/watch?v=xaeob9lTXS0 |
| 2 | Analysis of Three Phase unbalanced circuits | CO2 | https://www.youtube.com/watch?v=xaeob9lTXS0 |
| 3 | Transient response for RL and RC circuits | CO3 | https://www.youtube.com/watch?v=2MaPC8Iw7nc |
| 4 | Fourier Theorem | CO4 | https://nptel.ac.in/courses/108/104/108104139/ |
| 5 | RC, RL filters | CO5 | https://www.youtube.com/watch?v=AGyjYG88LlE |

**Text Book(s):**

1. William Hayt, Jack E. Kemmerly and Jamie Phillips, "Engineering Circuit Analysis", Mc Graw Hill, 9th Edition, 2019.
2. A. Chakrabarti, "Circuit Theory: Analysis & Synthesis", Dhanpat Rai & Sons, 2008.
3. Fundamentals of Electric Circuits, Charles K. Alexander, Mathew N. O. Sadiku, 3rd Edition, Tata McGraw-Hill, 2019

**Reference Book(s):**

1. M.E. Van Valkenberg, "Network Analysis", 3rd Edition, Prentice Hall (India), 1980.
2. V. Del Toro, "Electrical Engineering Fundamentals", Prentice Hall International, 2009.
3. Charles K. Alexander and Matthew. N. O. Sadiku, "Fundamentals of Electric Circuits" Mc Graw Hill, 5th Edition, 2013.
4. Mahamood Nahvi and Joseph Edminister, "Electric Circuits" Schaum's Series, 6th Edition, 2013.
5. John Bird, Routledge, "Electrical Circuit Theory and Technology", Taylor & Francis, 5th Edition, 2014.
6. Sudhakar, A., Circuits and Networks, Tata McGraw
7. Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education.
8. Network Analysis and Synthesis – Umesh Sinha- Satya Prakashan Publications
9. A. Anand Kumar, Network Analysis and Synthesis, PHI publication
10. Network Theory, N. C. Jagan and C. Lakshminarayana, 1st Edition, B. S. Publications, 2012.
11. Circuits and Networks Analysis and Synthesis, A. Sudhakar, Shyam Mohan S. Palli, 5th Edition, Tata McGraw-Hill, 2017.
12. Engineering Network Analysis and Filter Design (Including Synthesis of One Port Networks)- Durgesh C. KulshreshthaGopal G. Bhise, Prem R. Chadha ,Umesh Publications 2012.
13. Circuit Theory: Analysis and Synthesis, A. Chakrabarti, DhanpatRai& Co., 2018, 7th Revised Edition.

**Online Resources:**

1. http://www.acadmix.com/eBooks_Download
2. http://www.freetechbook.com/software-engineering-f15.html

**Web References:**

1) http://www.mathtutordvd.com/products/Engineering-Circuit-Analysis-Volume-1.cfm
2) http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-andelectronics-spring-2007/video-lectures/lecture-2/
3) http://www.facstaff.bucknell.edu/mastascu/elessonsHTML/Circuit/Circuit1.html
4) https://archive.nptel.ac.in/courses/117/106/117106108/
5) https://archive.nptel.ac.in/courses/108/105/108105159/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | DC MACHINES AND TRANSFORMERS | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand the constructional features of DC machines.
2. To understand the phenomena of armature reaction and commutation.
3. To understand the characteristics and parallel operation of dc machines.
4. To understand the methods for speed control of DC motors and applications of DC motors.
5. To understand the various types of losses that occurs in DC machines and how to calculate efficiency.
6. To understand the constructional features of a single phase transformer.
7. To understand the efficiency and voltage regulation of a transformer.
8. To understand the Autotransformers Construction & Comparison with two winding transformer.
9. To suggest a suitable three phase transformer connection for a particular operation.
10. To understand the tap changing of transformers.

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

| | |
|---|---|
| **CO 1** | Understand the process of voltage build-up in DC generators and characteristics. (BL2) |
| **CO 2** | Understand the process of torque production, starting and speed control of DC motors and illustrate their characteristics. (BL2) |
| **CO 3** | Obtain the equivalent circuit of single-phase transformer, auto transformer and determine its efficiency & regulation. (BL3) |
| **CO 4** | Apply various testing methods for transformers and speed control of DC motors. (BL3) |
| **CO 5** | Analyze various configurations of three-phase transformers. (BL4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO 2 |
| CO1 | 2 | 2 | 2 | 2 | | 2 | | | | 1 | 1 | 2 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 2 | | 2 | | | | 1 | 1 | 2 | 1 | 2 |
| CO3 | 2 | 2 | 2 | 2 | | 2 | | | | 1 | 1 | 2 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 2 | | 2 | | | | 1 | 1 | 2 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 3 | | 2 | | | | 1 | 1 | 2 | 1 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: DC Generators**

Construction and principle of operation of DC machines – EMF equation for generator – Excitation techniques– characteristics of DC generators –applications of DC Generators, Back-emf

| |
|---|
| and torque equations of DC motor – Armature reaction and commutation, Applications. |
| **MODULE -2: Starting, Speed Control and Testing of DC Machines** |
| Characteristics of DC motors – losses and efficiency – applications of DC motors. Necessity of a starter – starting by 3-point and 4-point starters – speed control by armature voltage and field current control – testing of DC machines – brake test, Swinburne's test –Hopkinson's test–Field Test. |
| **MODULE-3: Single-phase Transformers** |
| Introduction to single-phase Transformers (Construction and principle of operation)–emf equation – operation on no-load and on load –lagging, leading and unity power factors loads –phasor diagrams– equivalent circuit –regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – all day efficiency, Applications. |
| **MODULE-4: Testing of Transformers** |
| Open Circuit and Short Circuit tests – Sumpner's test – separation of losses— Parallel operation with equal and unequal voltage ratios– auto transformer – equivalent circuit – comparison with two winding transformers. |
| **MODULE-5: Three-Phase Transformers** |
| Polyphase connections- Y/Y, Y/Δ, Δ/Y, Δ/Δ, open Δ and Vector groups – third harmonics in phase voltages– Parallel operation–three winding transformers- transients in switching –off load and on load tap changers–Scott connection. |
| **Total hours: 54 hours** |

**Term work:**

DC Machines- Lab & Transformers- Filed Work

**Content beyond syllabus:**

1. Advanced Speed control techniques for DC Motors.
2. Zigzag/star and V/V connections in a 3-Phase Transformers

**Self-Study:**

Contents to promote self-Learning:

| S. No. | Topic | CO | Reference |
|---|---|---|---|
| 1 | DC Machines Introduction & Constructional features | CO1 | https://nptel.ac.in/courses/108/102/108102146/ |
| 2 | DC Generator Characteristics | CO2 | https://www.youtube.com/watch?v=TaZjv_sy_jo |
| 3 | DC Motor | CO3 | https://www.youtube.com/watch?v=GQatiB-JHdI |
| 4 | Testing of DC Machines | CO4 | https://www.youtube.com/watch?v=8WCbTZPjcTE |
| 5 | Transformers (Auto) | CO5 | https://nptel.ac.in/courses/108/105/108105155/ |

**Text Book(s):**

1. Electrical Machinery, Dr. P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.
2. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2014, 3rd Reprint 2015.
3. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
4. Performance and analysis of AC machines by M.G. Say, CBS, 2002.

**Reference Book(s):**

1..Electric Machines 4th edition, D.P.Kothari and I.J. Nagrath, Mc Graw Hill Education (India) Pvt. Ltd., 5th Edition.
2. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
3. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
4. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2011.
5. Generalized Theory of Electrical Machines by Dr. P S Bimbhra, 7th Edition, Khanna Publishers, 2021.
6. Theory & Performance of Electrical Machines by J.B.Gupta, S.K.Kataria & Sons, 2007.
7. Electric Machinery by Fitzgerald, A.E.,Kingsley, Jr.,C.,&Umans, S. D, 7th edition, McGraw-Hill Education, 2014.

**Online Resources:**

1. http://175.101.102.82/moodle/
2. https://www.accessengineeringlibrary.com/
3. https://www.slideshare.net/
4. https://easyengineering.net/electrical-machinery-by-bimbhra/
5.https://books.google.co.in/books?id=dh_gDwAAQBAJ&lpg=PR1&dq=electrical%20machines%20by%20kothari%202020&pg=PR8#v=onepage&q&f=false

**Web Resources:**

1. https://electrical-engineering-portal.com/
2. https://www.electrical4u.com/
3. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Sadhya/experimentlist.html
4. https://www.engineering.com/
5. nptel.ac.in/courses/108/105/108105112
6. nptel.ac.in/courses/108/105/108105155

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | **ELECTRICAL CIRCUIT ANALYSIS - II AND SIMULATION LAB** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| I | 0 | 0 | 3 | 54 | 1.5 | 30 | 70 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

The objectives are to study:

1. To design electrical systems.
2. To analyze a given network by applying various Network Theorems.
3. To measure three phase Active and Reactive power.
4. To understand the locus diagrams

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

| | |
|---|---|
| **CO 1** | Understand the power calculations in three phase circuits. (BL2) |
| **CO 2** | Analyze the time response of given network. (BL4) |
| **CO 3** | Determination of two port network parameters. (BL4) |
| **CO 4** | Simulate and analyze electrical circuits using software tools. (BL4) |
| **CO 5** | Apply various theorems to solve different electrical networks using simulation tools. (BL3) |

**CO-PO & PSO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | | | 2 | | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | | | 2 | 2 | | | 2 | 2 | 2 | | 2 | 2 |
| **CO3** | 3 | 3 | | | | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | | 2 | 2 | | 1 | 2 | 2 | | | 2 | 2 |
| **CO5** | 3 | 3 | 3 | | 2 | 2 | | 1 | 2 | 2 | | | 2 | 2 |

1 – Low Level; 2 – Moderate Level; 3 – High Level

## List of Experiments

**Any 10 of the following experiments are to be conducted:**

| |
|---|
| **TASK - 1 - Measurement of Active Power and Reactive Power for balanced loads.** |
| **TASK - 2 - Measurement of Active Power and Reactive Power for unbalanced loads.** |
| **TASK - 3 - Determination of Z and Y parameters.** |
| **TASK – 4 - Determination of ABCD and hybrid parameters** |
| **TASK - 5 - Verification of Kirchhoff's current law and voltage law using simulation tools.** |
| **TASK – 6 - Verification of mesh and nodal analysis using simulation tools.** |
| **TASK - 7 - Verification of super position and maximum power transfer theorems using simulation tools.** |

**TASK - 8 - Verification of Reciprocity and Compensation theorems using simulation tools.**

**TASK - 9 - Verification of Thevenin's and Norton's theorems using simulation tools.**

**TASK - 10 - Verification of series and parallel resonance using simulation tools.**

**TASK - 11 - Simulation and analysis of transient response of RL, RC and RLC circuits.**

**TASK - 12 - Verification of self-inductance and mutual inductance by using simulation tools.**

**Additional Experiments:**

**Virtual Lab:**

1. Parallel RC Circuits
2. Parallel LC Circuits
3. Series RL Circuits
4. Series LCR Circuit
5. Parallel LCR Circuits

**Text Book(s):**

1. Simulation of Power Electronics Circuit, M B Patil, V Ramanarayan and V T Ranganat, AlphaScience International Ltd., 2009.

**Reference Book(s):**

1. A Sudhakar, Shyammohan S Palli, "Circuits & Networks", Tata McGraw- Hill, 4th Edition, 2010.

2. WillamHayt.jr, Jack E.kemmerly,Steven M.Durbin, "Engineering Circuit analysis" Tata McGraw- Hill,8th Edition2012

3 A Chakrabarthy, "Electric Circuits", Dhanpat Rai & Sons, 6th Edition, 2010.

4 Rudrapratap, "Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers",Oxford University Press, 1 st Edition, 1999.

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | DC MACHINES AND TRANSFORMERS LAB | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| I | 0 | 0 | 3 | 54 | 1.5 | 30 | 70 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

1. To familiarize students about OCC and internal, external characteristics of dc shunt generator.
2. To know the performance characteristics and speed control method of dc shunt motor
3. To know how to predetermine the efficiency of dc shunt motor.
4. To find efficiency, losses and regulation of single phase transformer.
5. To know how to find motor and generator efficiency by connecting to dc shunt machines back to back
6. To familiarize students about characteristics of dc series motor

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

| | |
|---|---|
| **CO 1** | Demonstrate starting and speed control methods of DC Machines. L2 |
| **CO 2** | Apply theoretical concepts to determine the performance characteristics of DC Machines. L3 |
| **CO 3** | Analyze the parallel operation of single phase transformers. L4 |
| **CO 4** | Determine the performance parameters of single-phase transformer. L3 |
| **CO 5** | Analyze the performance analysis of transformers using various tests. L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 |
| CO1 | 3 | 3 | 3 | 2 | 2 | | | | 3 | 2 | | 3 | 3 | 3 |
| CO2 | 2 | 3 | 3 | 1 | 2 | | | | 2 | 2 | | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 1 | 2 | | | | 2 | 2 | | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 1 | 2 | | | | 2 | 2 | | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 1 | 2 | | | | 2 | 2 | | 3 | 3 | 3 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

## List of Experiments

**Any 10 of the following experiments are to be conducted:**

| |
|---|
| **TASK - 1 - Speed control of DC shunt motor by Field Current and Armature Voltage Control.** |
| **TASK - 2 - Brake test on DC shunt motor- Determination of performance curves.** |
| **TASK - 3 - Swinburne's test - Predetermination of efficiencies as DC Generator and Motor.** |
| **Task – 4 - Hopkinson's teston DC shunt Machines.** |
| **TASK - 5 - Load test on DC compound generator-Determination of characteristics.** |
| **TASK – 6 - Load test on DC shunt generator-Determination of characteristics.** |

| |
|---|
| **TASK - 7 - Fields test on DC series machines-Determination of efficiency.** |
| **TASK - 8 - Brake test on DC compound motor-Determination of performance curves.** |
| **TASK - 9 - OC & SC tests on single phase transformer.** |
| **TASK - 10 - Sumpner's test on single phase transformer.** |
| **TASK - 11 - Scott connection of transformers.** |
| **TASK - 12 - Parallel operation of Single-phase Transformers.** |
| **TASK - 13 - Separation of core losses of a single-phase transformer.** |
| **Text Book(s):**<br>1. Simulation of Power Electronics Circuit, M B Patil, V Ramanarayan and V T Ranganat, AlphaScience International Ltd., 2009. |
| **Reference Book(s):**<br>1. A Sudhakar, Shyammohan S Palli, "Circuits & Networks", Tata McGraw- Hill, 4th Edition, 2010.<br>2. WillamHayt.jr, Jack E.kemmerly,Steven M.Durbin, "Engineering Circuit analysis" Tata McGraw- Hill,8th Edition2012<br>3. A Chakrabarthy, "Electric Circuits", Dhanpat Rai & Sons, 6th Edition, 2010.<br>4. Rudrapratap, "Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers", Oxford University Press, 1 st Edition, 1999.<br>5. https://ems-iitr.vlabs.ac.in/List%20of%20experiments.html |

SEMESTER IV (2nd Year, 2nd Semester)

| Course Code | Category | Course Title | Contact Periods perweek | | | | Credits | Scheme of ExaminationMax. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 23MC8103 | ME-I | Managerial Economics and Financial Analysis | 2 | 0 | 0 | 2 | 2 | 30 | 70 | 100 |
| 23ES1005 | ES/BS | Analog Circuits | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2005 | PC | Power Systems-I | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2006 | PC | Induction and Synchronous Machines | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2007 | PC | Control Systems | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23SC6102 | SEC | Python Programming | 0 | 1 | 2 | 3 | 2 | 30 | 70 | 100 |
| 23ES1011 | ES | Design Thinking & Innovation | 1 | 0 | 2 | 3 | 2 | 30 | 70 | 100 |
| 23EE2505 | PC | Induction and Synchronous Machines Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23EE2506 | PC | Control Systems Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| | | Counseling / Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **15** | **1** | **13** | **29** | **21** | **270** | **630** | **900** |
| **Mandatory Community Service Project of 08 weeks duration during summer vacation** | | | | | | | | | | |

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | POWER SYSTEM - I | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

| **Pre-requisite:** Basic concepts of electrical circuits and theorems | |
|---|---|
| **Course Objectives:**<br>1. To understand the structure, essential components and their layout in non renewable generating stations.<br>2. To understand the electrical power generation from renewable energy sources as sun, wind and ocean.<br>3. To understand the calculation of different transmission line parameters and their use.<br>4. To understand the various effects in transmission line.<br>5. To understand the modeling of transmission line. | |
| **Course Outcomes**: On successful completion of the course, student will be able to: | |
| **CO 1** | Understand the different types of power plants, operation of power plants. (BL2) |
| **CO 2** | Understand the concepts of distribution systems, underground cables, economic aspects and tariff (BL2) |
| **CO 3** | Understand various substations that are located in distribution systems (BL2) |
| **CO 4** | Apply the above concepts to illustrate different power generation layouts (BL3) |
| **CO 5** | Analyze various economic aspects related to power generation and distribution (BL4) |

| CO-PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **PO** | | | | | | | | | | | | **PSO** | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 1 | 2 | 2 | | | | | | | | | | 2 | 2 |
| **CO2** | 2 | 3 | | | | | | | | | | | 3 | 2 |
| **CO3** | 3 | 2 | | | | | | | | | | | 3 | 2 |
| **CO4** | 2 | 3 | 1 | | | | | | | | | | 1 | 3 |
| **CO5** | 3 | 3 | | | | | | | | | | | 1 | 1 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

| Course Content |
|---|
| **MODULE – 1: Hydroelectric & Thermal Power Stations** |
| **Hydroelectric Power Stations:**<br>Selection of site, general layout of a hydroelectric power plant with brief description of major components and principle of operation<br>**Thermal Power Stations:**<br>Selection of site, general layout of a thermal power plant. Brief description of components: boilers, super heaters, economizers and electrostatic precipitators, steam turbines: impulse and reaction turbines, condensers, feed water circuit, cooling towers and chimney. |
| **MODULE-2: Nuclear Power Stations** |

Location of nuclear power plant, working principle, nuclear fission, nuclear fuels, nuclear chain reaction, nuclear reactor components: moderators, control rods, reflectors and coolants, types of nuclear reactorsand brief description of PWR, BWR and FBR. Radiation: radiation hazards and shielding, nuclear waste disposal.

**MODULE-3: Substations**

**Air Insulated Substations** – indoor & outdoor substations, substations layouts of 33/11 kV showing the location of all the substation equipment.Bus bar arrangements in the substations: simple arrangements like single bus bar, sectionalized single bus bar, double bus bar with one and two circuit breakers, main and transfer bus bar system with relevant diagrams.

**Gas Insulated Substations (GIS)** – advantages of gas insulated substations, constructional aspects of GIS, comparison of air insulated substations and gas insulated substations.

**MODULE-4: Distribution Systems & Cables**

**Distribution Systems:**

Classification of Distribution systems, A.C Distribution, Overhead versus Underground system,Connection schemes of Distribution system, Requirements of Distribution system, Design considerations in Distribution system.

**Underground Cables:**

Types of cables, construction, types of insulating materials, calculation of insulation resistance, stress in insulation and power factor of cable.Capacitance of single and 3-Core belted Cables. Grading of cables: capacitance grading and intersheath grading.

**MODULE-5: Economic Aspects & Tariff**

**Economic Aspects –** load curve, load duration and integrated load duration curves, discussion on economic aspects: connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity factor and plant use factor, base and peak load plants.

**Tariff Methods–** Costs of generation and their division into fixed, semi-fixed and running costs, desirable characteristics of a tariff method, tariff methods: simple rate, flat rate, blockrate, two-part, three–part, and power factor tariff methods, Time of Day (ToD) tariff and Time of Use (ToU) tariff.

| | **Total hours:** | **54 hours** |
|---|---|---|

**Text Book(s):**


1. Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A.Chakraborti, Dhanpat Rai &Co. Pvt. Ltd., 1999
2. Non Conventional Energy Sources by G.D. Rai, Khanna Publishers, 2000.
3. S. N. Singh, Electric Power Generation, Transmission and Distribution, PHI Learning Pvt Ltd, New Delhi, 2nd Edition, 2010
4. 2. J. B. Gupta, Transmission and Distribution of Electrical Power, S. K. Kataria and sons,10th Edition, 2012


**Reference Book(s):**


1. Principles of power systems by V.K.Mehta,Rohith Mehta S.Chand(P), 4th Edition
2. "Generation of Electrical Energy"- by B.R Gupta-S.Chand Publications,6th Edition(Reprint 2014)
3. Electrical Power Systems for Industrial Plants, Kamalesh Das, JAICO Publishing House,

2008.

4. Electrical power systems, C.L.Wadhwa, New Age International (P) Limited, 6th Edition, 2014
5. I.J.Nagarath& D.P. Kothari, Power System Engineering, McGraw-Hill Education, 3rd Edition, 2019.
6. Turan Gonen, Electric Power Distribution System Engineering, McGraw-Hill, 1985.
7. Handbook of switchgear, BHEL, McGraw-Hill Education, 2007.

**Content beyond syllabus:**

1. Betz criterion, wind energy applications.
2. Underground Cables.

**Online Resources:**

**https://www.ibef.org/industry/power-sector-india**

**https://www.slideshare.net/sidhu007/non-conventional-sources-of-energy-30135444**

**https://www.energy.gov/eere/water/types-hydropower-plants**

**https://www.academia.edu/34930327/Insulators**

**Web Resources:**

**https://www.birdvilleschools.net**

**https://www.learnpick.in/prime/documents/ppts/details/4866/solar-cell-technology**

**https://courses.engr.illinois.edu**

**https://vikaspedia.in/energy/energy-production/wind-energy/types-of-wind-energy-conversion-devices**

**https://www.learnpick.in/prime/documents/ppts/details/3777/biomass-conversion-technologies**

**https://nptel.ac.in/courses/108102047**

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | **INDUCTION AND SYNCHRONOUS MACHINES** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand the Constructional details, principle of operation and the importance of slip in Induction motor operation
2. To understand the slip-torque characteristics and torque calculations of Induction motor
3. To understand the methods of starting and speed control of Induction motor
4. To understand the construction and principle of working of synchronous machines
5. To understand the different methods of predetermining the regulation of alternators
6. To understand the concepts and computation of load sharing among alternators in parallel.
7. To understand the performance characteristics of synchronous motors and their use as synchronous condensers for power factor improvement.
8. To understand the different types of single phase motors and special motors used in house hold appliances and control systems.

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

| | |
|---|---|
| **CO 1** | Understand the construction, principle and operation of single phase and three phase induction motors (BL-2) |
| **CO 2** | Understand the construction, principle and operation of synchronous generator and Synchronous motor (BL-2) |
| **CO 3** | Understand various applications of various alternating machines (BL-2) |
| **CO 4** | Apply the above concepts to solve various mathematical and complex problems (BL-3) |
| **CO 5** | Analyze the characteristics of induction motor, synchronous motor and synchronous generators (BL-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 |
| CO1 | 3 | 2 | 1 | | | | | | | | | | 2 | 2 |
| CO2 | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO3 | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| CO4 | 3 | 2 | 1 | | | | | | | | | | 2 | 2 |
| CO5 | 3 | 2 | 1 | | | | | | | | | | 2 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: 3-phase induction motors**

Construction of Squirrel cage and Slipring induction motors– production of rotating magnetic field – principle of operation – rotor emf and rotor frequency – rotor current and power factor at standstill and during running conditions– rotor power input, rotor copper loss and mechanical power developed and their inter-relationship –equivalent circuit – phasor diagram, Applications.

**MODULE -2: Performance of 3-Phase induction motors**

Torque equation – expressions for maximum torque and starting torque – torque-slip characteristics – double cage and deep bar rotors –No load, Brake test and Blocked rotor tests – circle diagram for predetermination of performance- methods of starting –starting current and torque calculations -speed control of induction motor with V/f control method, rotor resistance control and rotor emf injection technique –crawling and cogging – induction generator operation.

**MODULE-3: Single Phase Motors**

Single phase induction motors – constructional features – double revolving field theory, Cross field theory – equivalent circuit- starting methods: capacitor start capacitor run, capacitor start induction run, split phase & shaded pole, AC series motor, Applications.

**MODULE-4: Synchronous Generator**

Constructional features of non-salient and salient pole type alternators- armature windings - distributed and concentrated windings – distribution& pitch factors – E.M.F equation – armature reaction – voltage regulation by synchronous impedance method – MMF method and Potier triangle method –two reaction analysis of salient pole machines -methods of synchronization- Slip test – Parallel operation of alternators.

**MODULE-5: Synchronous Motor**

Synchronous motor principle and theory of operation – Effect of excitation on current and power factor– synchronous condenser –expression for power developed –hunting and its suppression – methods of starting, Applications.

**Total hours: 54 hours**

**Term work:**

Synchronous machines & Induction machines- Power plants & Industrial visits.

**Content beyond syllabus:**

1. Advanced Speed Control methods for Poly phase Induction Motors.
2. Two Reaction Theory –Determination of Xd and $X_q$ (Slip Test).
3. Principle of operation and control of Brushless DC motor.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | 3-phase Induction Motors | CO1 | https://nptel.ac.in/courses/108/102/108102146/ |
| 2 | Circle Diagram | CO2 | https://nptel.ac.in/courses/108/105/108105131/ |
| 3 | Synchronous Generator | CO3 | https://www.youtube.com/watch?v=b24jORRoxEc |
| 4 | Parallel operation of Alternators | CO4 | https://www.youtube.com/watch?v=aZR7JsH9QnM |
| 5 | Synchronous motor | CO5 | https://www.youtube.com/watch?v=fdMIuEqh48M&list=PLPpCFgQP7QKHSJQnSwaigL89gshecycXs |

**Text Book(s):**

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.
2. Performance and analysis of AC machines by M.G. Say, CBS, 2002.

**Reference Book(s):**

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
5. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2014, 3rd Reprint 2015.
6. Electric Machines 4th edition, D.P.Kothari and I.J. Nagrath, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2010, 16th Reprint 2015.
7. Electrical machines, D.P. Kothari and I.J. Nagrath, McGraw Hill Education, 2017, Fifth Edition.
8. Theory & Performance of Electrical Machines by J.B.Gupta, S.K.Kataria& Sons,2007.

**Online Resources:**

1. http://175.101.102.82/moodle/
2. https://www.accessengineeringlibrary.com/
3. https://www.slideshare.net/
4. https://easyengineering.net/electrical-machinery-by-bimbhra/
5. https://books.google.co.in/books?id=dh_gDwAAQBAJ&lpg=PR1&dq=electrical%20machines%20by%20kothari%202020&pg=PR8#v=onepage&q&f=false

**Web Resources:**

1. https://electrical-engineering-portal.com/
2. https://www.electrical4u.com/
3. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Sadhya/experimentlist.html
4. https://www.engineering.com/
5. https://nptel.ac.in/courses/108/105/108105131
6. https://nptel.ac.in/courses/108106072

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | CONTROL SYSTEMS | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

1. To understand the merits and demerits of open and closed loop control systems
2. To understand the mathematical modeling of Electrical and mechanical control systems
3. To understand the step response of second order control systems
4. To plot Root locus for the given system transfer function
5. To understand the stability analysis from Bode plot, polar plots
6. To understand the state space analysis

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

| | |
|---|---|
| **CO 1** | Understand the concepts of various mathematical representations of control systems, Time response of first order and second order systems, stability, frequency response and fundamentals of modern control systems (BL-2) |
| **CO 2** | Apply Block diagram reduction, Signal flow graph, Routh criterion, Root locus, Bode, Polar, Nyquist concepts for solving various numerical problems (BL-3) |
| **CO 3** | Analyze time response characteristics, frequency response characteristics, stability analysis of various control systems (BL-4) |
| **CO 4** | Design various compensators and controllers for different control systems by using design procedures (BL-5) |
| **CO 5** | Create suitable control systems for various real time applications (BL-5) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 |
| CO1 | 3 | 2 | | | | | | | | | | | | 1 |
| CO2 | 2 | 1 | | | | | | | | | | | | 1 |
| CO3 | 2 | 1 | | | | | | | | | | | | 1 |
| CO4 | 2 | 1 | 1 | | | | | | | | | | | 1 |
| CO5 | 2 | 1 | 1 | | | | | | | | | | | 1 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: CONTROL SYSTEMS CONCEPTS

Open loop and closed loop control systems and their differences- Examples of control systems- Classification of control systems, Feedback characteristics, Effects of positive and negative feedback, Mathematical models – Differential equations of translational and rotational mechanical systems and electrical systems, Analogous Systems, Block diagram reduction methods – Signal flow graphs - Reduction using Mason's gain formula. Principle of

operation of DC and AC Servo motor, Transfer function of DC servo motor - AC servo motor, Synchros.

**MODULE-2: TIME RESPONSE ANALYSIS**

Step Response - Impulse Response - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems – Time domain specifications – Steady state response - Steady state errors and error constants, P, PI, PID Controllers.

**MODULE-3: STABILITY ANALYSIS IN TIME DOMAIN**

The concept of stability – Routh's stability criterion – Stability and conditional stability – limitations of Routh's stability. The Root locus concept - construction of root loci-effects of adding poles and zeros to G(s)H(s) on the root loci.

**MODULE-4: FREQUENCY RESPONSE ANALYSIS**

Introduction, Frequency domain specifications-Bode diagrams-Determination of Frequency domain specifications and transfer function from the Bode Diagram-Stability Analysis from Bode Plots. Polar Plots-Nyquist Plots- Phase margin and Gain margin-Stability Analysis. Compensation techniques – Lag, Lead, Lag-Lead Compensator design in frequency Domain.

**MODULE-5: STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS**

Concepts of state, state variables and state model, state models - differential equations & Transfer function models - Block diagrams. Diagonalization, Transfer function from state model, Solving the Time invariant state Equations- State Transition Matrix and it's Properties. System response through State Space models. The concepts of controllability and observability, Duality between controllability and observability.

| | |
|---|---|
| **Total hours:** | **54 hours** |

**Term work:** Problem solving with any software

**Content beyond syllabus:**

1. Introduction to P,PI,PID controllers.
2. State space representation of Armature and Field controlled DC motor.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Open Loop and closed loop control systems | CO1 | https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm |
| 2 | Block diagram rules | CO2 | https://www.tutorialspoint.com/control_systems/control_systems_block_diagram_algebra.htm |
| 3 | Time response of second order system | CO3 | https://www.tutorialspoint.com/control_systems/control_systems_time_response_analysis.htm |
| 4 | Routh's stability criteria | CO4 | https://www.tutorialspoint.com/control_systems/control_systems_stability_analysis.htm |

| | | | | |
|---|---|---|---|---|
| | 5 | Frequency domain specifications | CO5 | https://www.tutorialspoint.com/control_systems/control_systems_frequency_response_analysis.htm |

**Text Book(s):**

1. " Control Systems Engineering, I. J. Nagrath and M. Gopal, New Age International Publishers, 5th edition, 2007, Reprint 2012.
2. Control Systems by A. Anand Kumar, PHI Learning pvt. Ltd., second edition
3. Modern Control Engineering by Katsuhiko Ogata, Prentice Hall of India Pvt. Ltd., 5th edition, 2010.

**Reference Book(s):**

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013
2. Modern Control Engineering, Katsuhiko Ogata, PEARSON, 1st Impression 2015.
3. Control Systems Principles & Design by M.Gopal, 4th Edition, Mc Graw Hill Education, 2012.
4. Automatic Control Systems by B. C. Kuo and Farid Golnaraghi, John wiley and sons, 8th edition, 2003.
5. Feedback and Control Systems, Joseph J Distefano III, Allen R Stubberud & Ivan J Williams, 2nd Edition, Schaum's outlines, Mc Graw Hill Education, 2013.
6. Control System Design by Graham C. Goodwin, Stefan F. Graebe and Mario E. Salgado, Pearson, 2000.
7. Feedback Control of Dynamic Systems by Gene F. Franklin, J.D. Powell and Abbas Emami-Naeini, 6th Edition, Pearson, 2010.

**Online Resources:**

1. http://www.aoengr.com/SampleBook.pdf
2. http://www.ent.mrt.ac.lk/~rohan/teaching/EN5001/Reading/DORFCH1.pdf

**Web Resources:**

1. https://nptel.ac.in/courses/107/106/107106081/
2. https://www.tutorialspoint.com/control_systems/index.htm
3. https://www.youtube.com/watch?v=XYbrgwKP_6k
4. https://nptel.ac.in/courses/108102043
5. https://nptel.ac.in/courses/108106098

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | INDUCTION AND SYNCHRONOUS MACHINES LAB | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 0 | 0 | 3 | 54 | 1.5 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To find the performance of induction motor by calculating the efficiency.
2. To find direct and quadrature axis reactances of synchronous motor.
3. To find voltage regulation by using various methods on synchronous machine4.To determine 'v' and 'inverted v' curves of synchronous motor.
5. To find the efficiency and power factor from circle diagram byconducting no load andblocked rotor test on 3-phase induction motor.

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

| | |
|---|---|
| **CO 1** | Analyze various performance characteristics of 3-phase and 1-phase induction Motors (BL-4) |
| **CO 2** | Evaluate the performance of 3-phase Induction Motor by obtaining the circle diagram and equivalent circuit of 3-phase Induction Motor and single phase induction motor (BL-4) |
| **CO 3** | Adapt the power factor improvement methods for single phase Induction Motor (BL-3) |
| **CO 4** | Pre-determine the regulation of 3-phase alternator (BL-3) |
| **CO 5** | Determine the synchronous machine reactance of 3-phase alternator (BL-3) |

**List of Experiments:**

**Any 10 experiments of the following are required to be conducted**

TASK-1: Brake test on three phase Induction Motor.
TASK-2. Circle diagram of three phase induction motor.
TASK-3. Speed control of three phase induction motor by V/f method.
TASK-4. Equivalent circuit of single-phase induction motor.
TASK-5. Power factor improvement of single-phase induction motor by using capacitors.
TASK-6. Load test on single phase induction motor.
TASK-7. Regulation of a three -phase alternator by synchronous impedance &MMF methods.
TASK-8. Regulation of three-phase alternator by Potier triangle method.
TASK-9. V and Inverted V curves of a three-phase synchronous motor.
TASK-10. Determination of Xd, Xq& Regulation of a salient pole synchronous generator.
TASK-11. Determination of efficiency of three phase alternator by loading with three phase induction motor.
TASK-12. Parallel operation of three-phase alternator under no-load and load conditions.
TASK-13. Determination of efficiency of a single-phase AC series Motor by conducting Brake test.

**Text Book(s):**

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.
2. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition,2014, 3rd Reprint 2015.

**Reference Book(s):**

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw HillEducation, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. https://em-coep.vlabs.ac.in/List%20of%20experiments.html

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | CONTROL SYSTEMS LAB | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 0 | 0 | 3 | 54 | 1.5 | 30 | 70 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

The objectives are to study:

1.To provide practical knowledge for Time response of second order system

2. Determine of transfer functions of various systems and control of it by different Methodologies

3. The characteristics of Magnetic Amplifier, servo mechanisms which are helpful in automatic control systems

4. Determine the stability analysis of different system by using PSPICE and MATLAB

5. To study the closed loop performance for the given plant using P, PD, PI, PID Controllers.

6. The design of controllers/compensators to achieve desired specifications.

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

| | |
|---|---|
| **CO 1** | Understand how to use feedback control system to determine transfer function of DC servo motor and any other given circuit with R, L and C components (BL-2) |
| **CO 2** | Model the systems and able to design the controllers and compensators. (BL-3) |
| **CO 3** | Get the knowledge about the effect of poles and zeros location on transient and steady state behavior of second order systems and implement through software tools (BL-4) |
| **CO 4** | Determine the performance and time domain specifications of first and second order systems. (BL-4) |
| **CO 5** | Understand the stability analysis (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 |
| CO1 | 3 | 2 | | | 3 | | | | 2 | 2 | | 3 | 3 | 3 |
| CO2 | 2 | 3 | 3 | 3 | 3 | | | | 3 | 2 | | 3 | 3 | 3 |
| CO3 | 2 | 2 | 3 | 2 | 3 | | | | 2 | 2 | | 3 | 3 | 2 |
| CO4 | 2 | 2 | 3 | 2 | 3 | | | | 2 | 2 | | 3 | 3 | 2 |
| CO5 | 2 | 2 | 3 | 2 | 3 | | | | 2 | 2 | | 3 | 3 | 2 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

**List of Experiments:**

**Any 10 of the Following Experiments are to be conducted.**

TASK-1. Time response of Second order system

TASK-2. Characteristics of Synchros

TASK-3. Programmable logic controller – Study and verification of truth tables of logic gates,

simple Boolean expressions and application of speed control of motor.

TASK-4. Effect of feedback on DC servo motor

TASK-5. Transfer function of DC Machine

TASK-6. Effect of P, PD, PI, PID Controller on a second order system

TASK-7. Lag and lead compensation – Magnitude and phase plot

TASK-8. Temperature controller using PID

TASK-9. Characteristics of magnetic amplifiers

TASK-10. Characteristics of AC servo motor

TASK-11. Linear system analysis (Time domain analysis, Error analysis) using MATLAB.

TASK-12. Stability analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant system using MATLAB

TASK-13. State space model for classical transfer function using MATLAB – Verification.

**Text Book(s):**

1. Simulation of Electrical and electronics Circuits using PSPICE - by M.H Rashid, M/S PHI Publications.
2. MATLAB and its Tool Books yser's manual and - Mathworks, USA
3. I. J. Nagrath and M. Gopal, "Control Systems Engineering"5th edition, New AgeInternational (P) Limited Publishers, 2007.

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**For Electronics and Communication Engineering Department**

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| II-B.Tech | LINEAR CONTROL SYSTEMS | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:** Basics concepts of Electrical Circuits & Basics of Laplace transform

**Course Objectives:**

1. Introduce the basic principles and applications of control systems.
2. Learn the time response and steady state response of the systems.
3. Know the time domain analysis and solutions to time invariant systems.
4. Understand different aspects of stability analysis of systems in frequency domain.
5. Understand the concept of state space, controllability and observability.

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

| | |
|---|---|
| **CO 1** | Summarize the basic principles and applications of control systems. (BL2) |
| **CO 2** | Understand the time response and steady state response of the systems. (BL2) |
| **CO 3** | Understand the concept of state space, controllability and observability. (BL2) |
| **CO 4** | Apply time domain analysis to find solutions to time invariant systems. (BL3) |
| **CO 5** | Analyze different aspects of stability analysis of systems in frequency domain. (BL4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 |
| CO1 | 3 | 2 | | | | | | | | | | | | 1 |
| CO2 | 2 | 1 | | | | | | | | | | | | 1 |
| CO3 | 2 | 1 | | | | | | | | | | | | 1 |
| CO4 | 2 | 1 | 1 | | | | | | | | | | | 1 |
| CO5 | 2 | 1 | 1 | | | | | | | | | | | 1 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: CONTROL SYSTEMS CONCEPTS

Open loop and closed loop control systems and their differences- Examples of control systems- Classification of control systems, Feedback characteristics, Effects of positive and negative feedback, Mathematical models – Differential equations of translational and rotational mechanical systems and electrical systems, Analogous Systems, Block diagram reduction methods – Signal flow graphs - Reduction using Mason's gain formula. Controller

components, DC Servomotor and AC Servomotor- their transfer functions, Synchros

**MODULE-2: TIME RESPONSE ANALYSIS**

Step Response - Impulse Response - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications – Steady state response - Steady state errors and error constants, Study of effects and Design of P, PI, PD and PID Controllers on second order system.

**MODULE-3: STABILITY ANALYSIS IN TIME DOMAIN**

The concept of stability – Routh's stability criterion – Stability and conditional stability - limitations of Routh's stability. The Root locus concept - construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root loci.

**MODULE-4: FREQUENCY RESPONSE ANALYSIS**

**Frequency Response Analysis:** Introduction, Frequency domain specifications-Bode diagrams-Determination of Frequency domain specifications and transfer function from the Bode Diagram - Stability Analysis from Bode Plots. Polar Plots- Nyquist Plots- Phase margin and Gain margin-Stability Analysis.

Compensation techniques – Study of Effects and Design of Lag, Lead, Lag-Lead Compensator design in frequency Domain on a second order system.

**MODULE-5: STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS**

Concepts of state, state variables and state model - differential equations & Transfer function models - Block diagrams. Diagonalization, Transfer function from state model, solving the Time invariant state Equations- State Transition Matrix and it's Properties. System response through State Space models. The concepts of controllability and observability, Duality between controllability and observability.

At the end of the Module 5, students will be able to:

1. Understand the importance of state space analysis
2. Find the state model for the given transfer function through various techniques.
3. Determine the controllability and observability of given state model.

| | |
|---|---|
| **Total hours:** | **54 hours** |

**Term work:** Problem solving with any software

**Content beyond syllabus:**

1. Introduction to P,PI,PID controllers.
2. State space representation of Armature and Field controlled DC motor.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Open Loop and closed loop control systems | CO1 | https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm |
| 2 | Block diagram rules | CO2 | https://www.tutorialspoint.com/control_systems/control_systems_block_diagram_algebra.htm |

| | | | | |
|---|---|---|---|---|
| | 3 | Time response of second order system | CO3 | https://www.tutorialspoint.com/control_systems/control_systems_time_response_analysis.htm |
| | 4 | Routh's stability criteria | CO4 | https://www.tutorialspoint.com/control_systems/control_systems_stability_analysis.htm |
| | 5 | Frequency domain specifications | CO5 | https://www.tutorialspoint.com/control_systems/control_systems_frequency_response_analysis.htm |

**Text Book(s):**

1. " Control Systems Engineering, I. J. Nagrath and M. Gopal, New Age International Publishers, 5th edition, 2007, Reprint 2012.
2. Control Systems by A. Anand Kumar, PHI Learning pvt. Ltd., second edition
3. Modern Control Engineering by Katsuhiko Ogata, Prentice Hall of India Pvt. Ltd., 5th edition, 2010.

**Reference Book(s):**

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013
2. Modern Control Engineering, Katsuhiko Ogata, PEARSON, 1st Impression 2015.
3. Control Systems Principles & Design by M.Gopal, 4th Edition, Mc Graw Hill Education, 2012.
4. Automatic Control Systems by B. C. Kuo and Farid Golnaraghi, John wiley and sons, 8th edition, 2003.
5. Feedback and Control Systems, Joseph J Distefano III, Allen R Stubberud & Ivan J Williams, 2nd Edition, Schaum's outlines, Mc Graw Hill Education, 2013.
6. Control System Design by Graham C. Goodwin, Stefan F. Graebe and Mario E. Salgado, Pearson, 2000.
7. Feedback Control of Dynamic Systems by Gene F. Franklin, J.D. Powell and Abbas Emami-Naeini, 6th Edition, Pearson, 2010.

**Online Resources:**

1. http://www.aoengr.com/SampleBook.pdf
2. http://www.ent.mrt.ac.lk/~rohan/teaching/EN5001/Reading/DORFCH1.pdf

**Web Resources:**

**1. https://nptel.ac.in/courses/107/106/107106081/**
**2. https://www.tutorialspoint.com/control_systems/index.htm**
**3. https://www.youtube.com/watch?v=XYbrgwKP_6k**
**4. https://nptel.ac.in/courses/108102043**
**5. https://nptel.ac.in/courses/108106098**

NARAYANA ENGINEERING COLLEGE::GUDUR
NAAC 'A' GRADE (AUTONOMOUS)
Dhurjati Nagar, Gudur, Tirupati Dist., AP - 524101

# DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
## Regulation: NECR B.TECH 23

SEMESTER V (3rd Year, 1st Semester)

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 23EE2008 | PC | Power Electronics | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2009 | PC | Digital Circuits | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2010 | PC | Power Systems-II | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23ES1014 | ES | Introduction to Quantum Technology & Applications | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | PE-I | Professional Elective - I | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | OE-I | Open Elective-I | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23SC6104 | SEC | Soft Skills | 0 | 1 | 2 | 3 | 2 | 30 | 70 | 100 |
| 23ES1507 | ES | Tinkering Lab | 0 | 0 | 2 | 2 | 1 | 30 | 70 | 100 |
| 23EE2507 | PC | Power Electronics Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23EE2508 | PC | Analog and Digital Circuits Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| | | Counseling / Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| 23PR7501 | Internship | Evaluation of Community Service Internship | 0 | 0 | 0 | 0 | 2 | -- | -- | -- |
| | | Activity Point Programme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **15** | **1** | **15** | **31** | **23** | **330** | **770** | **1100** |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | POWER ELECTRONICS | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To understand the various applications of Power electronic devices for conversion, control and conditioning of the electrical power and to get an overview of different types of power semiconductor devices and their dynamic characteristics.
2. To understand the operation, characteristics and performance parameters of controlled rectifiers.
3. To study the operation, switching techniques and basics topologies of DC-DC switching regulators.
4. To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.

**Course Outcomes**: At the end of this course, the students will be able to

| | |
|---|---|
| **CO 1** | Understand the I-V Characteristics and Gate Drive Requirements of Power Devices Including Diodes, Thyristors, MOSFETs, and IGBTs. -L2 |
| **CO 2** | Design Single-Phase and Three-Phase Rectifiers with Different Load Conditions and Evaluate Power Factor and Source Inductance Effects. -L5 |
| **CO 3** | Apply Duty Ratio Control and Analyze Steady-State Waveforms of Buck, Boost, and Buck-Boost Converters. L3 |
| **CO 4** | Analyze the Operation of Inverters with Various Load Conditions and Commutation Techniques. L4 |
| **CO 5** | Analyze the Operation of AC Voltage Controllers, and Cyclo Converters with Various Load Conditions and Commutation Techniques. L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |
| CO2 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |
| CO3 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |
| CO4 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |
| CO5 | 3 | 2 | 3 | | | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Power Switching Devices

Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET, IGBT and GTO. Introduction to Galium Nitride and Silicon Carbide Devices.

### MODULE -2: Rectifiers

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape, power factor and effect of source inductance; Analysis of rectifiers with filter capacitance, Dual Converter -Numerical problems.

| MODULE-3: DC-DC Converters | |
|---|---|
| Elementary chopper with an active switch and diode, concepts of duty ratio, control strategies and average output voltage: Power circuit, analysis and waveforms at steady state, duty ratio control and average output voltage of Buck, Boost and Buck- Boost Converters. | |
| **MODULE-4: Inverters** | |
| Single phase Voltage Source inverters – operating principle - steady state analysis, Simple forced commutation circuits for bridge inverters – Voltage control techniques for inverters and Pulse width modulation techniques, single phase current source inverter with ideal switches, basic series inverter, single phase parallel inverter – basic principle of operation only, Three phase bridge inverters (VSI) – 180 degree mode – 120 degree mode of operation - Numerical problems. | |
| **MODULE-5: AC Voltage Controllers & Cyclo Converters** | |
| AC voltage controllers – Principle of phase control – Principle of integral cycle control - Single phase two SCRs in anti-parallel – With R and RL loads – modes of operation of Triac – Triac with R and RL loads – RMS load voltage, current and power factor - wave forms – Numerical problems. Cyclo converters - Midpoint and Bridge connections - Single phase to single phase step-up and step-down cyclo converters with Resistive and inductive load, Principle of operation, Waveforms, output voltage equation. | |
| **Total hours:** | 54 |

**Term work:**

Report submission on Multilevel converters with MATLAB-Simulation.

**Content beyond syllabus:**

Three phase cycloconverters

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | IGBT | CO1 | https://www.youtube.com/watch?v=ekSbhm4l0Go |
| 2 | Commutation techniques of SCR | CO2 | https://www.youtube.com/watch?v=mf-97ZXrOz0 https://www.youtube.com/watch?v=h7cu27etdmg https://www.youtube.com/watch?v=WX5G0RHozAs https://www.youtube.com/watch?v=d4sbVc-r7I4 |
| 3 | Three phase converters | CO3 | https://www.youtube.com/watch?v=VYmd3KKfCQQ |
| 4 | Switching mode regulators | CO4 | https://www.youtube.com/watch?v=Q7cTuZIH8IA https://www.youtube.com/watch?v=I0ZbC7uCe9A https://www.youtube.com/watch?v=YiYQjdARZ7I |
| 5 | Resonant Pulse inverters | CO5 | https://www.youtube.com/watch?v=AISpcLLiOPA |

**Text Book(s):**

1. M. H. Rashid, ―Power Electronics: Circuits, Devices and Applications‖, 2nd edition, Prentice Hall of India, 1998.
2. P.S. Bimbhra, ―Power Electronics‖, 4th Edition, Khanna Publishers, 2010.
3. M. D. Singh & K. B. Kanchandhani, ―Power Electronics‖, Tata Mc Graw Hill Publishing Company, 1998.

**Reference Book(s):**

1. Ned Mohan, ―Power Electronics‖, Wiley, 2011.
2. Robert W. Erickson and Dragan Maksimovic, ―Fundamentals of Power Electronics‖ 2nd Edition, Kluwer Academic Publishers, 2004.
3. Vedam Subramanyam, ―Power Electronics‖, New Age International (P) Limited, 1996.
4. V. R. Murthy, ―Power Electronics‖, 1st Edition, Oxford University Press, 2005.
5. P. C. Sen, ―Power Electronics‖, Tata Mc Graw-Hill Education, 1987.
6. J. M. D. Murphy ―Power Electronic Control of Alternating Current Motors‖.

**Online Resources:**

1. https://books.google.co.in/books?id=0_D6gfUHjcEC&printsec=frontcover#v=onepage&q&f=false
2. https://nptel.ac.in/courses/108/105/108105066/

**Web Resources:**

1. https://www.youtube.com/watch?v=ZbvWe9xBu3Q&list=PLp6ek2hDcoND7i5- DAD9mPmYF1Wg6ROdO
2. https://www.youtube.com/watch?v=1Auay7ja2oY&list=PLA07ACBDE053A8229

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | POWER SYSTEMS - II | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To study about line parameters and constants
2. To study the performance of transmission lines
3. To know about overhead line insulators, corona, sag and tension in transmission lines
4. To study about symmetrical components and different types of faults in power system.
5. To understand the concept of voltage control, compensation methods

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Analyse the transmission lines and obtain the transmission line parameters and constants. L4 |
| **CO 2** | Analyse transmission line performance.L4 |
| **CO 3** | Design transmission lines to meet the day to day power requirements.L5 |
| **CO 4** | Understand and apply Per Unit System for Fault Calculations. L2 |
| **CO 5** | Apply load compensation techniques to control reactive power. L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | | | | | | | | | | | 3 | 2 |
| CO2 | 2 | 3 | 1 | | 1 | | | | | | | | 1 | 3 |
| CO3 | 3 | 3 | | | | | | | | | | | 1 | 1 |
| CO4 | 3 | 3 | | | | | | | | | | | 2 | 2 |
| CO5 | 3 | 3 | | | | | | | | | | | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Transmission Line Parameters

Types of Conductors - Calculation of Resistance for Solid Conductors, Bundle Conductors, Skin effect, Proximity effect, Concept of GMR & GMD- Transposition of Power lines- Calculation of inductance for single phase and three phase, Single and Double circuit lines, Symmetrical and asymmetrical conductor configurations with and without transposition. Calculation of Capacitance for 2 wire and 3 wire systems, effect of ground on Capacitance, Capacitance calculations for symmetrical and asymmetrical single and three phase, single and double circuit lines, Numerical Problems

### MODULE -2: Performance of Transmission Lines

Classification of Transmission Lines-Short, medium and long line and their models representation - Nominal-T, Nominal-$\pi$ and A, B, C, D Constants for symmetrical networks, Numerical Problems and solutions for estimating regulation and efficiency of all types of lines. Ferranti effect and Charging Current

### MODULE-3: Overhead Line Insulators

Types of Insulators, String efficiency and Methods for improvement, – Voltage Distribution, Calculation of String efficiency, Capacitance Grading and Static Shielding., Numerical Problems.

**Sag and Tension:** Sag and Tension Calculations with equal and unequal heights of towers, Effect of wind and ice on weight of conductor, Stringing chart, Sag template and its applications Numerical Problems.

**Corona:** Corona- factors affecting corona, critical voltages and Power loss due to Corona. Radio Interference

**MODULE-4: Short Circuit Analysis**

Per-Unit System, Per-Unit equivalent reactance network of a three phase power system. Short circuit current and MVA calculations, fault levels, application of Series Reactors. Numerical problems

**Symmetrical Components and Fault Analysis:** Symmetrical component theory, symmetrical component transformation. Positive, negative and zero sequence components of voltages, currents and impedances

Positive, negative and zero sequence networks LG, LL, LLG faults with and without fault impedance and LLL fault. Numerical Problems

**MODULE-5: Voltage Control and Power Factor Improvement**

Methods of voltage control, shunt and series capacitors / Inductors, tap changing transformers, synchronous phase modifiers, power factor improvement methods.

**Compensation in Power Systems:** Concepts of Load compensation Load ability characteristics of overhead lines – Uncompensated transmission line – Symmetrical line – Radial line with asynchronous load – Compensation of lines.

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**

Field work to EHV Substation and report submission.

**Content beyond syllabus:**

Underground Cables.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Capacitance calculation | CO1 | https://www.youtube.com/watch?v=BSvnx3iVd5Y |
| 2 | Long transmission line | CO2 | https://www.youtube.com/watch?v=mFXtZ_kkQSk |
| 3 | Electrical Corona | CO3 | https://www.youtube.com/watch?v=m-jeQgXAqJA |
| 4 | Types of electrical faults | CO4 | https://www.youtube.com/watch?v=UE3OYs5oO74 |
| 5 | Power factor improvement | CO5 | https://www.youtube.com/watch?v=14PLVZKQ19Y |

**Text Book(s):**

1. C.L. Wadhwa, ―Electrical Power Systems‖, New Age International Pub. Co, Third Edition, 2001.

2. D.P. Kothari and I.J. Nagrath, ―Modern Power System Analysis‖, Tata Mc Graw Hill Pub. Co.,New Delhi, Fourth edition, 2011.
3. B.R.Gupta,―Power System Analysis and Design‖, S.ChandPublishing.1998.

**Reference Book(s):**

1. A. Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, ―A Text book on Power System Engineering‖, Dhanpat Rai Publishing Company (P) Ltd, 2008.
2. John J. Grainger & W.D. Stevenson, ―Power System Analysis‖, Mc Graw Hill International,1994.
3. Hadi Sadat, ―Power System Analysis‖, Tata Mc Graw Hill Pub. Co. 2002.
4. W.D. Stevenson, ―Elements of Power system Analysis‖, McGraw Hill International Student Edition.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc22_ee17/preview

**Web Resources:**

1. https://b-ok.asia/book/1117604/f01d10
2. https://b-ok.asia/book/2729267/f90c96
3. https://nptel.ac.in/courses/108/102/108102047/
4. https://nptel.ac.in/courses/108/107/108107112/
5. https://www.youtube.com/watch?v=ptiaNGkuylY

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **INTRODUCTION TO QUANTUM TECHNOLOGIES AND APPLICATIONS** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. Introduce fundamental quantum concepts like superposition and entanglement.
2. Understand theoretical structure of qubits and quantum information.
3. Explore conceptual challenges in building quantum computers.
4. Explain principles of quantum communication and computing.
5. Examine real-world applications and the future of quantum technologies.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Explain core quantum principles in a non-mathematical manner. L2 |
| **CO 2** | Compare classical and quantum information systems. L2 |
| **CO 3** | Identify theoretical issues in building quantum computers. L2 |
| **CO 4** | Discuss quantum communication and computing concepts. L2 |
| **CO 5** | Recognize applications, industry trends, and career paths in quantum technology. L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | - | - | - | - | - | - | - | 2 | - | 2 | 2 | 2 |
| CO2 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 2 | 2 |
| CO4 | 2 | 2 | - | 2 | 3 | - | - | - | - | 2 | - | 2 | 2 | 2 |
| CO5 | 1 | - | - | - | 2 | 2 | - | - | 1 | 3 | 2 | 3 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

**MODULE – 1:** Introduction to Quantum Theory and Technologies

The transition from classical to quantum physics, Fundamental principles explained conceptually: Superposition, Entanglement, Uncertainty Principle, Wave-particle duality, Classical vs Quantum mechanics – theoretical comparison,Quantum states and measurement: nature of observation,Overview of quantum systems: electrons, photons, atoms,The concept of quantization: discrete energy levels,Why quantum? Strategic, scientific, and technological significance,A snapshot of quantum technologies: Computing, Communication, and Sensing,National and global quantum missions: India's Quantum Mission, EU, USA, China

**MODULE -2:** Theoretical Structure of Quantum Information Systems

What is a qubit? Conceptual understanding using spin and polarization, Comparison: classical bits vs quantum bits, Quantum systems: trapped ions, superconducting circuits, photons (non-engineering view),Quantum coherence and decoherence – intuitive explanation, Theoretical concepts: Hilbert spaces, quantum states, operators – only interpreted in abstract,The role of entanglement and non-locality in systems, Quantum information vs classical information: principles and differences,Philosophical implications: randomness, determinism, and observer role

**MODULE-3:** Building a Quantum Computer – Theoretical Challenges and Requirements

| |
|---|
| What is required to build a quantum computer (conceptual overview)?, Fragility of quantum systems: decoherence, noise, and control, Conditions for a functional quantum system: Isolation, Error management, Scalability, Stability, Theoretical barriers: Why maintaining entanglement is difficult,Error correction as a theoretical necessity, Quantum hardware platforms (brief conceptual comparison),Superconducting circuits, Trapped ions, Photonics, Visionvs reality: what's working and what remains elusive,The role of quantum software in managing theoretical complexities |
| **MODULE-4:** Quantum Communication and Computing – Theoretical Perspective |
| Quantum vs Classical Information, Basics of Quantum Communication, Quantum Key Distribution (QKD),Role of Entanglement in Communication,The Idea of the Quantum Internet – Secure Global Networking,Introduction to Quantum Computing,Quantum Parallelism (Many States at Once),Classical vs Quantum Gates, Challenges: Decoherence and Error Correction,Real-World Importance and Future Potential |
| **MODULE-5:** Applications, Use Cases, and the Quantum Future |
| Real-world application domains: Healthcare (drug discovery),Material science, Logistics and optimization, Quantum sensing and precision timing, Industrial case studies: IBM, Google, Microsoft, PsiQuantum,Ethical, societal, and policy considerations, Challenges to adoption: cost, skills, standardization, Emerging careers in quantum: roles, skillsets, and preparation pathways,Educational and research landscape – India's opportunity in the global quantum race |

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**

Report submission on any one case studies

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Classical vs Quantum mechanics | CO1 | https://quantumatlas.umd.edu/entry/quantum-classical/ |
| 2 | Quantum coherence and decoherence | CO2 | https://en.wikipedia.org/wiki/Quantum_decoherence |
| 3 | Fragility of quantum systems | CO3 | https://link.springer.com/chapter/10.1007/978-3-642-33860-1_5 |
| 4 | Basics of Quantum Communication | CO4 | https://www.sciencedirect.com/topics/earth-and-planetary-sciences/quantum-communication |
| 5 | Emerging careers in quantum | CO5 | https://mahatmaschools.com/emerging-opportunities-in-quantum-physics/ |

**Text Book(s):**


1. Michael A. Nielsen, Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 10th Anniversary Edition, 2010.
2. Eleanor Rieffel and Wolfgang Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
3. Chris Bernhardt, *Quantum Computing for Everyone*, MIT Press, 2019.

**Reference Book(s):**


1. David McMahon, *Quantum Computing Explained*, Wiley, 2008.
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press, 2007.
3. Scott Aaronson, *Quantum Computing Since Democritus*, Cambridge University Press, 2013.
4. **Alastair I.M. Rae**, *Quantum Physics: A Beginner's Guide*, Oneworld Publications, Revised Edition, 2005.
5. **Eleanor G. Rieffel, Wolfgang H. Polak**, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
6. **Leonard Susskind, Art Friedman**, *Quantum Mechanics: The Theoretical Minimum*, Basic Books, 2014.
7. **Bruce Rosenblum, Fred Kuttner**, *Quantum Enigma: Physics Encounters Consciousness*, Oxford University Press, 2nd Edition, 2011.
8. **GiulianoBenenti, GiulioCasati, GiulianoStrini**, *Principles of Quantum Computation and Information, Volume I: Basic Concepts*, World Scientific Publishing, 2004.
9. **K.B. Whaley et al.**, *Quantum Technologies and Industrial Applications: European Roadmap and Strategy Document*, Quantum Flagship, European Commission, 2020.
10. **Department of Science & Technology (DST), Government of India**, *National Mission on Quantum Technologies & Applications – Official Reports and Whitepapers*, MeitY/DST Publications, 2020 onward.


**Online Resources:**

- IBM Quantum Experience and Qiskit Tutorials
- Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley
- edX – The Quantum Internet and Quantum Computers

**Web Resources:**

- YouTube – Quantum Computing for the Determined by Michael Nielsen
- Qiskit Textbook – IBM Quantum

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | POWER ELECTRONICS LAB | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| I | 0 | 0 | 3 | 54 | 1.5 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. This course is intended to acquire practical knowledge about the operation of various power converters.
2. To understand the basics of triggering circuits required for various power converters.

**Course Outcomes**: At the end of this course, the students will be able to

| | |
|---|---|
| **CO 1** | Analyze the Characteristics of Power Semiconductor Devices (SCR, MOSFET, IGBT) and their Role in Power Converters. L4 |
| **CO 2** | Design and Implement Gate Firing Circuits for SCR-based Power Converters. L4 |
| **CO 3** | Evaluate the Performance of Single-phase and Three-phase Power Converters with R and RL Loads. L5 |
| **CO 4** | Apply Different Commutation Techniques to Analyze Inverter for Efficient Power Control. L3 |
| **CO 5** | Apply Different Commutation Techniques to Analyze Chopper Circuits for Efficient Power Control. L3 |

**CO-PO & PSO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | | | | 2 | 2 | | | 3 | 2 |
| **CO2** | 2 | 3 | | | 2 | | | | 2 | 2 | | | 3 | 2 |
| **CO3** | 3 | 3 | | | 2 | | | | 2 | 2 | | | 3 | 2 |
| **CO4** | 2 | 3 | | | 2 | | | | 2 | 2 | | | 3 | 2 |
| **CO5** | 3 | 3 | | | 2 | | | | 2 | 2 | | | 3 | 2 |

1 – Low Level; 2 – Moderate Level; 3 – High Level

## List of Experiments

**Any 10 of the following experiments are to be conducted:**

| |
|---|
| **TASK - 1 - Study of Characteristics of SCR, MOSFET & IGBT** |
| **TASK - 2 - Gate firing circuits for SCR's: (a) R triggering (b) R-C triggering** |
| **TASK - 3 - Single Phase AC Voltage Controller with R and RL Loads** |
| **TASK – 4 - Single Phase fully controlled bridge converter with R and RL loads** |
| **TASK - 5 - Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E).** |
| **TASK – 6 - DC Jones chopper with R and RL Loads** |
| **TASK - 7 - Single Phase Parallel inverter with R and RL loads** |
| **TASK - 8 - Single Phase Cycloconverter with R and RL loads** |

| |
|---|
| **TASK - 9 - Single Phase Half controlled converter with R and RL load** |
| **TASK - 10 - Single Phase Fully controlled converter with R and RL load** |
| **TASK - 11 - Three Phase half-controlled bridge converter with R, RL-load** |
| **TASK - 12 - Three Phase fully controlled bridge converter with R, RL-load** |
| **TASK – 13 - Single Phase series inverter with R and RL loads** |
| **TASK – 14 - Single Phase Bridge converter with R and RL loads** |
| **TASK – 15 - Single Phase dual converter with RL loads** |
| **Additional Experiments:**<br>**Online Learning Resources/Virtual Labs:**<br>http://vlabs.iitb.ac.in/vlabs-ev/labs/mit_bootcamp/power_electronics/labs/index.php |
| **Text Book(s):**<br>1. O.P. Arora, ―Power Electronics Laboratory: Theory, Practice and Organization (Narosa series in Power and Energy Systems)‖, Alpha Science International Ltd., 2007.<br>2. M. H. Rashid, ―Simulation of Electric and Electronic circuits using PSPICE‖, M/s PHI Publications. |
| **Reference Book(s):**<br>1. PSPICE A/D user‘s manual – Microsim, USA.<br>2. PSPICE reference guide – Microsim, USA. 5. MATLAB and its Tool Books user‘s manual and – Math works, USA. |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | TINKERING LAB | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| I | 2 | 0 | 0 | 36 | 1 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge.

The objectives of the course are to:

1. Encourage Innovation and Creativity
2. Provide Hands-on Learning and Impart Skill Development
3. Foster Collaboration and Teamwork
4. Enable Interdisciplinary Learning, Prepare for Industry and Entrepreneurship
5. Impart Problem-Solving mind-set

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

**Course Outcomes**: The students will be able to experiment, innovate, and solve real-world challenges

**CO-PO & PSO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 3 |

1 – Low Level; 2 – Moderate Level; 3 – High Level

## List of Experiments

**Any 10 of the following experiments are to be conducted:**

| |
|---|
| **TASK - 1 - Make your own parallel and series circuits using breadboard for any application of your choice.** |
| **TASK - 2 - Demonstrate a traffic light circuit using breadboard** |
| **TASK - 3 - Build and demonstrate automatic Street Light using LDR** |
| **TASK – 4 - Simulate the Arduino LED blinking activity in Tinkercad** |
| **TASK - 5 - Build and demonstrate an Arduino LED blinking activity using Arduino IDE** |
| **TASK – 6 - Interfacing IR Sensor and Servo Motor with Arduino** |
| **TASK - 7 - Blink LED using ESP32** |

**TASK - 8 - LDR Interfacing with ESP32**

**TASK - 9 - Control an LED using Mobile App**

**TASK - 10 - Design and 3D print a Walking Robot**

**TASK - 11 - Design and 3D Print a Rocket**

**TASK - 12 - Build a live soil moisture monitoring project, and monitor soil moisture levels of a remote plan in your computer dashboard**

**TASK – 13 - Demonstrate all the steps in design thinking to redesign a motor bike**

**Text Book(s):**

1. **"The Art of Tinkering"**
   *By: Karen Wilkinson, Mike Petrich*
   - Publisher: Weldon Owen
   - A creative guide with inspiring tinkering projects using everyday materials.
2. **"Tinkering: Kids Learn by Making Stuff"**
   *By: Curt Gabrielson*
   - Publisher: Maker Media
   - Great for building basic to intermediate engineering models and science toys.
3. **"Make: Electronics – Learning by Discovery" (2nd Edition)**
   *By: Charles Platt*
   - Publisher: Maker Media
   - Practical electronics exploration; ideal for circuits, sensors, and prototypes.
4. **"Practical Electronics for Inventors" (4th Edition)**
   *By: Paul Scherz and Simon Monk*
   - McGraw-Hill Education
   - Excellent for understanding electronics fundamentals with applications.
5. **"Getting Started with Arduino" (3rd Edition)**
   *By: Massimo Banzi, Michael Shiloh*
   - Maker Media
   - Entry-level guide to Arduino for prototyping real-time systems.
6. **"Creative Confidence: Unleashing the Creative Potential Within Us All"**
   *By: Tom Kelley and David Kelley*
   - Publisher: Crown Business
   - Focuses on innovation mindset, very relevant for Tinkering/Idea Labs.
7. **"Design Thinking for Strategic Innovation"**
   *By: Idris Mootee*
   - Publisher: Wiley
   - Strategic approach to turning ideas into viable solutions.
8. **"Make: Tools – How They Work and How to Use Them"**
   *By: Charles Platt*
   - Excellent resource for understanding and using hand/power tools safely.
9. **"Invent to Learn: Making, Tinkering, and Engineering in the Classroom"**
   *By: Sylvia Libow Martinez and Gary Stager*
   - Covers curriculum design and hands-on learning pedagogy.

**Students need to refer to the following links:**

1) https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2) https://atl.aim.gov.in/ATL-Equipment-Manual/
3) https://aim.gov.in/pdf/Level-1.pdf
4) https://aim.gov.in/pdf/Level-2.pdf
5) https://aim.gov.in/pdf/Level-3.pdf

SEMESTER VI (3rd Year, 2nd Semester)

| Course Code | Category | Course Title | Contact Periods perweek | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 23EE2001 | PC | Electrical Measurements and Instrumentation | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2012 | PC | Microprocessors and Microcontrollers | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23EE2013 | PC | Power System Analysis | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | PE-II | Professional Elective – II | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | PE-III | Professional Elective - III | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | OE-II | Open Elective – II | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| 23SC6112 | SEC | Applications of Soft Computing Tools in Electrical Engineering | 0 | 1 | 2 | 3 | 2 | 30 | 70 | 100 |
| 23EE2509 | PC | Electrical Measurements and Instrumentation Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23EE2510 | PC | Microprocessors and Microcontrollers Lab | 0 | 0 | 3 | 3 | 1.5 | 30 | 70 | 100 |
| 23MC8103 | AC | Technical Paper Writing & IPR | 2 | 0 | 0 | 2 | 0 | -- | 100 | 100 |
| | | Counseling / Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | | Activity PointProgramme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **20** | **1** | **13** | **34** | **23** | **330** | **870** | **1200** |
| **Mandatory Industry Internship of 08 weeks duration during summer vacation** | | | | | | | | | | |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | ELECTRICAL MEASUREMENTS AND INSTRUMENTATION | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To study about the working principle of electrical measuring instruments
2. To study the performance of instrumental transformers, power factor, frequency and energy meters
3. To study the functioning of DC and AC bridges
4. To study the basics of digital volt meters and transducers
5. To understand the concept of sensors and data acquisition systems

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understand principle and working of electrical measuring instruments L2 |
| **CO 2** | Understand the principle of operation of instrument transformers, energy meters and analog instruments L2 |
| **CO 3** | Understand the principle and working of various DC and AC bridges for the measurement of Resistance, Inductance and Capacitance L2 |
| **CO 4** | Understand the principle and working of different digital voltmeters and transducers L2 |
| **CO 5** | Understand the working of various sensors and data acquisition systems L2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO2 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO3 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO4 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |
| CO5 | 3 | 3 | 2 | | | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Measuring instruments & Digital Meters

**Fundamentals:** True Value, Errors (Gross, Systematic, Random); Static Characteristic of Instruments (Accuracy, Precision, Sensitivity, Resolution & threshold); Error Analysis-Simple problems; Statistical treatment of data-Simple problems.

**Indicating Instruments:** Three forces in Electromechanical indicating instrument (Deflecting, controlling & damping forces); Moving iron type (attraction and repulsion), PMMC, Electrodynamometer Type instruments: Torque equation (Expression only, no derivation), shape of scale – simple problems on torque equations; Measurement of voltage and current - Extension of Range of ammeter and voltmeter – problems on extension of range of ammeter and voltmeter.

### MODULE -2: Measurement Of Power, Power Factor And Energy

**Instrument transformers:** Types, CT and PT – Ratio and phase angle errors; (Expression only, no derivation)

**Measurement of power:** Principle and Operation of Single-phase dynamometer wattmeter, expression (Expression only no derivation) for deflecting and control torques, errors and

compensations.

**Measurement of power factor:** Principle and operation of Single-phase Electrodynamometer Power factor meter.

**Measurement of Frequency:** Principle and Operation of single phase frequency meter- vibrating reed type, - ferro dynamic type meter.

**Measurement of Energy:** Principle and Operation of Single phase induction type energy meter, driving and braking torques (expression only no derivation), errors and compensations, testing by phantom loading

**MODULE-3: D.C&A.C Bridges**

**Measurement of Resistance:** Methods of measuring low, medium and high resistances – Sensitivity of Whetstone's bridge– Kelvin's double bridge for Measuring low resistance, Megger for measurement of high resistance.

**Measurement of Inductance:** Maxwell's bridge, Anderson's bridge.

**Measurement of Capacitance:** De Sauty bridge. Wien's bridge–Scheringbridge–Numerical problems.

**MODULE-4: Digital Volt Meters And Transducers**

**Digital Voltmeters:** Ramp type, Dual Slope integrating type, successive approximation, Potentiometric type DVMs.

**Classification of transducers:** Active/passive, analog/digital- Strain Gauge-gauge factor (Elementary treatment only)-applications of strain gauge, Q-Meter.

**MODULE-5: Transducers, Sensors and Data Acquistion**

Definition of Transducers, Classification of Transducers, Advantages of Electrical Transducers, Characteristics and Choice of Transducers; Principle Operation of Resistor, Inductor and Capacitive Transducers; LVDT and its Applications, Strain Gauge and Its Principle of Operation, Gauge Factor, Thermistors, Thermocouples, Piezo Electric Transducers, Photo electric Transducers, Hall effect, Photo Diodes. Optocoupler.

**Silicon based micro sensors:** Pressure sensor, Gyro sensor, Accelerometer, Flow sensor, Proximity sensor, Temperature sensor, Humidity sensor. (Elementary treatment only)

**Introduction to PLC and SCADA Systems:** Data acquisition systems (DAS) and interfacing techniques.

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**

Term work shall consist of report on substation where various measuring instruments can be observed.

**Content beyond syllabus:**

Miscellaneous Measuring Instruments: Maximum demand indicators

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | PMMC INSTRUMENT | CO1 | https://www.tutorialspoint.com/electronic_measuring_instruments/electronic_measuring_instruments_dc_voltmeters.htm |
| 2 | ENERGY METER | CO2 | https://circuitglobe.com/energy-meter.html |
| 3 | DC & AC BRIDGES | CO3 | https://www.tutorialspoint.com/electronic_measuring_instr |

| | | | | |
|---|---|---|---|---|
| | | | | uments/electronic_measuring_instruments_dc_bridges.htm |
| | 4 | POTENTIOMETER | CO4 | https://www.youtube.com/watch?v=i05A2sfO7Xc&list=PL227ZNwByTlTGq1atJsFst_qnEptI870O&index=33 |
| | 5 | TRANSDUCERS | CO5 | https://www.tutorialspoint.com/electronic_measuring_instruments/electronic_measuring_instruments_transducers.htm |

**Text Book(s):**

1. Electrical & Electronic Measurement & Instruments by A.K. Sawhney Dhanpat Rai & Co. Publications, 2007.
2. Electrical Measurements and measuring Instruments–by E.W.Golding and F.C. Widdis, 5th Edition, Reem Publications, 2011.
3. Buckingham and Price, ―Electrical Measurements‖, Prentice – Hall

**Reference Book(s):**

1. Electronic Instrumentation by H.S.Kalsi,Tata Mcgrawhill, 3rd Edition, 2011.
2. Electrical Measurements: Fundamentals, Concepts, Applications–by Reissl and, M.U, New Age International (P) Limited, 2010.
3. Electrical & Electronic Measurement & Instrumentation by R.K.Rajput, 2nd Edition, S. Chand & Co., 2nd Edition, 2013.
4. Sensor Technology: Hand Book by JonS. Wilson, ELSEVIER publications,2005

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc22_ee112/preview

**Web Resources:**

1. https://b-ok.asia/book/2563619/2f98e0
2. https://civildatas.com/download/electronic-and-electrical-measuring-instruments-machines-by-bakshi
3. https://books.google.co.in/books?id=Q6uBCgAAQBAJ&pg=PA9&lpg=PA9&dq=measurements+for+today&source=bl&ots=oXNqMKSLxk&sig=ACfU3U2cEvMiC6pSV205CRFO3WM8vC1HMQ&hl=en&sa=X&ved=2ahUKEwjNq6Lsx4_qAhXlQ3wKHaM4DZ0Q6AEwD3oECAgQAQ#v=onepage&q=measurements%20for%20today&f=false
4. https://nptel.ac.in/courses/108/105/108105153/
5. http://www.instrumentationtoday.com/
6. https://www.youtube.com/watch?v=n1MinLtvnPY&list=PL227ZNwByTlTGq1atJsFst_qnEptI870O&index=2

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | POWER SYSTEM ANALYSIS | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. The use of per unit values and graph theory concepts, solving a problem using computer.
2. Formation of Ybus and Zbus of a Power System network, power flow studies by various methods.
3. Different types of faults and power system analysis for symmetrical and also unsymmetrical faults.
4. Analysis of power system for steady state and transient stability and also methods to improve stability

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Remember and understand the concepts of per unit values, Y Bus and Z bus formation, load flow studies, symmetrical and unsymmetrical fault calculations. L1 |
| **CO 2** | Apply the concepts of good algorithm for the given power system network and obtain the converged load flow solution and experiment some of these methods using modern tools and examine the results. L4 |
| **CO 3** | Analyse the symmetrical faults and unsymmetrical faults and done the fault calculations, analyse the stability of the system and improve the stability. L3 |
| **CO 4** | Demonstrate the use of these techniques through good communication skills. L5 |
| **CO 5** | Develop accurate algorithms for different networks and determine load flow studies and zero, positive and negative sequence impedances to find fault calculations. L5 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: PER-UNIT System and Ybus Formation

Per-Unit representation of Power system elements - Per-Unit equivalent reactance network of a three phase Power System - Graph Theory: Definitions, Bus Incidence Matrix, YBus formation by Direct and Singular Transformation Methods, Numerical Problems.

### MODULE -2: Formation of Zbus

Formation of ZBus: Partial network, Algorithm for the Modification of ZBus Matrix for addition element for the following cases: Addition of element from a new bus to reference, Addition of element from a new bus to an old bus, Addition of element between an old bus to reference and Addition of element between two old busses - Modification of ZBusfor the changes in network

| MODULE-3: Power Flow Analysis | |
|---|---|
| Static load flow equations – Load flow solutions using Gauss Seidel Method: Algorithm and Flowchart. Acceleration Factor, Load flow Solution for Simple Power Systems (Max. 3-Buses): Newton Raphson Method in Polar Co-Ordinates Form: Load Flow Solution- Jacobian Elements, Algorithm and Flowchart. Decoupled and Fast Decoupled Methods.- Comparison of Different Methods | |
| **MODULE-4: Short Circuit Studies** | |
| Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors. Symmetrical Component Theory: Positive, Negative and Zero sequence components, Positive, Negative and Zero sequence Networks. Symmetrical Fault Analysis: LLLG faults with and without fault impedance, Unsymmetrical Fault Analysis: LG, LL and LLG faults with and without fault impedance, Numerical Problems. | |
| **MODULE-5: Stability Analysis** | |
| Elementary concepts of Steady State, Dynamic and Transient Stabilities. Derivation of Swing Equation, Power Angle Curve and Determination of Steady State Stability. Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation. Numerical methods for solution of swing equation - Methods to improve Stability - Application of Auto Reclosing and Fast Operating Circuit Breakers. | |
| **Total hours:** | 54 |

**Term work:**

Field work of load flow in power system

**Content beyond syllabus:**

knowledge of Multi machine stability in power system.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Representation of power System Network Matrices | CO1 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |
| 2 | Load Flow Studies | CO2 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |
| 3 | Newton Raphson Method | CO3 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |
| 4 | Short Circuit current and MVA Calculations | CO4 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |
| 5 | Power system Stabilities | CO5 | http://175.101.102.82/moodle/mod/folder/view.php?id=17046 |

**Text Book(s):**

1. Computer Methods in Power System Analysis by G.W.Stagg and A.H.El-Abiad, Mc Graw-Hill, 2006.
2. Modern Power system Analysis by I.J.Nagrath&D.P.Kothari, Tata McGraw-Hill Publishing Company, 4th Edition, 2011.

**Reference Book(s):**

1. Power System Analysis by Grainger and Stevenson, McGraw Hill, 1994.
2. Power System Analysis by Hadi Saadat, McGraw Hill, 1998.
3. Power System Analysis and Design by B.R.Gupta, S. Chand & Company, 2005.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc22_ee120/preview

**Web Resources:**

1. **http://175.101.102.82/moodle/course/view.php?id=693**
2. **http://www.acadmix.com/eBooks_Download**
3. **https://nptel.ac.in/courses/108105067/**
4. **https://nptel.ac.in/course.html**
5. **http://175.101.102.82/moodle/course/view.php?id=693**
6. **https://lecturenotes.in/subject/482/power-system-analysis-psa/note**
7. **https://www.youtube.com/watch?v=j44kQiphUB4&list=PL1XaeVNXKsvwkfUAGQiUuqWBswJ4VM3Ed**
8. **https://www.youtube.com/watch?v=-bX0k5Dlwek&list=PLgzsL8klq6DJv0G1l7ji4OI8BTXgEADfP**
9. **https://www.youtube.com/watch?v=tb3gCr9m0LU&list=PLtcRcIUOKppXWUMEVXGwwULXgzEBygOK-**
10. **https://www.youtube.com/watch?v=fBm1dr_gRBk&list=PL36A60B630E8C7B56**
11. **https://www.youtube.com/watch?v=NfnrupJ0BwY&list=PLfDaOYdi9aZyO2oYhr7G9DYMhoFmqS4A1**

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **TECHNICAL PAPER WRITING AND INTELLECTUAL PROPER RIGHTS** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 2 | 0 | 0 | 36 | 0 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To enable the students to practice the basic skills of research paper writing
2. To make the students understand the importance of IP and to educate them on the basic concepts of Intellectual Property Rights.
3. To practice the basic skills of performing quality literature review
4. To help them in knowing the significance of real life practice and procedure of Patents.
5. To enable them learn the procedure of obtaining Patents, Copyrights, & Trade Marks

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Identify key secondary literature related to their proposed technical paper writing. L1, L2 |
| **CO 2** | Explain various principles and styles in technical writing. L1, L2 |
| **CO 3** | Use the acquired knowledge in writing a research/technical paper. L3 |
| **CO 4** | Analyse rights and responsibilities of holder of Patent, Copyright, Trademark, International Trademark etc. L4 |
| **CO 5** | Evaluate different forms of IPR available at national & international levels also develop skill of making search of various forms of IPR by using modern tools and techniques. L5, L3, L6 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | | 1 | 2 | | | 1 | | 2 | | 3 | | |
| CO2 | 2 | | | | 1 | | | 2 | 1 | 3 | 2 | 3 | | |
| CO3 | 3 | 2 | 2 | 2 | 2 | | | 2 | 1 | 3 | 2 | 3 | | |
| CO4 | 2 | | | | | 2 | | 3 | | 2 | 2 | 2 | | |
| CO5 | 2 | 2 | | 2 | 3 | | | 2 | | 2 | 2 | 3 | | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: Principles of Technical Writing**

Styles in technical writing; clarity, precision, coherence and logical sequence in writing-avoiding ambiguity- repetition, and vague language -highlighting your findings-discussing your limitations -hedging and criticizing -plagiarism and paraphrasing.

**MODULE -2: Technical Research Paper Writing**

**Technical Research Paper Writing:** Abstract- Objectives-Limitations-Review of Literature-Problems and Framing Research Questions- Synopsis.

**MODULE-3: Process of research: publication mechanism**

| |
|---|
| Types of journals- indexing-seminars- conferences- proof reading –plagiarism style; seminar & conference paper writing; Methodology-discussion-results- citation rules |
| **MODULE-4: Introduction to Intellectual property** |
| Introduction, types of intellectual property, International organizations, agencies and treaties, importance of intellectual property rights<br>**Trade Marks:** Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes. |
| **MODULE-5: Law of copy rights & Patents** |
| **Law of copy rights:** Fundamentals of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law<br>**Law of patents:** Foundation of patent law, patent searching process, ownership rights and transfer. Patent law, intellectual property audits. |

| | |
|---|---|
| **Total hours:** | 36 |

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Logical sequence in writing | CO1 | https://www.cuyamaca.edu/student-support/tutoring-center/files/student-resources/logical-flow-in-writing.pdf |
| 2 | Review of Literature | CO2 | https://www.sjsu.edu/writingcenter/docs/handouts/Literature%20Reviews.pdf |
| 3 | Types of journals in Electrical | CO3 | https://kcgcollege.ac.in/pdf/eee/List%20of%20E-%20Resources_EEE%20Department%20Library.pdf |
| 4 | Types of intellectual property | CO4 | https://thelegalschool.in/blog/types-of-intellectual-property |
| 5 | Fundamentals of copy right law | CO5 | https://www.slideshare.net/slideshow/fundamental-of-copy-right-law/239011198 |

**Text Book(s):**

1. Deborah. E. Bouchoux, Intellectual Property Rights, Cengage Learning India, 2013
2. Meenakshi Raman, Sangeeta Sharma. Technical Communication:Principles and practices.Oxford.

**Reference Book(s):**

1. R.Myneni, Law of Intellectual Property, 9th Ed, Asia law House, 2019.
2. Prabuddha Ganguli,Intellectual Property Rights Tata Mcgraw Hill, 2001
3. P.Naryan,Intellectual Property Law, 3rd Ed ,Eastern Law House, 2007.
4. Adrian Wallwork. English for Writing Research PapersSecond Edition. Springer Cham Heidelberg New York ,2016
5. Dan Jones, Sam Dragga, Technical Writing Style

**Online Resources:**

1. https://theconceptwriters.com.pk/principles-of-technical-writing/
2. https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/TechPaperWriting.html
3. https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/TechPaperWriting.html
4. https://www.manuscriptedit.com/scholar-hangout/process-publishing-research-paper-journal/

**Web Resources:**

1. https://www.icsi.edu/media/website/IntellectualPropertyRightLaws&Practice.pdf
2. https://lawbhoomi.com/intellectual-property-rights-notes/
3. https://www.extension.purdue.edu/extmedia/ec/ec-723.pdf

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LAB | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 0 | 0 | 3 | 54 | 1.5 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** To make the students learn about

1. Calibration of various electrical measuring instruments
2. Accurate determination of inductance and capacitance using AC Bridges
3. Measurement of resistance for different range of resistors using bridges
4. Performance of transducers and sensors

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Determine the unknown Resistance, Inductance and Capacitance using AC and DC bridges.-L3 |
| **CO 2** | Understand the calibration of single phase energy meter.-L2 |
| **CO 3** | Understand the measurement of power, power factor in a single phase circuit and real, reactive Power in a three phase circuit. -L2 |
| **CO 4** | Extend the range of Ammeter and Voltmeter. -L5 |
| **CO 5** | Understand the working of Transducers, Measure distance, temperature, current, voltage and humidity using sensors. -L2 |

**CO-PO & PSO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 2 | 1 | | | | | 2 | 2 | | | | 1 |
| **CO2** | 2 | 2 | 2 | 1 | | | | 1 | 2 | 2 | | | | 2 |
| **CO3** | 2 | 2 | 1 | 1 | | | | 1 | 2 | 2 | | | | 1 |
| **CO4** | 2 | 2 | 2 | 1 | 1 | | | 1 | 2 | 2 | | | | 2 |
| **CO5** | 2 | 2 | 2 | 1 | 1 | | | 1 | 2 | 2 | | | | 2 |

1 – Low Level; 2 – Moderate Level; 3 – High Level

## List of Experiments

**Any 10 of the following experiments are to be conducted:**

| |
|---|
| **TASK - 1 - Measurement of resistance using Wheatstone bridge and Kelvin‘s Double Bridge.** |
| **TASK - 2 - Measurement of inductance using Maxwell‘s bridge, Anderson bridge.** |
| **TASK - 3 - Measurement of capacitance using De-Sauty's bridge, Schering bridge.** |
| **TASK – 4 - Calibration of single phase energy meter using direct loading method.** |
| **TASK - 5 - Calibration of energy meter using Phantom load kit.** |
| **TASK – 6 - Measurement of Power using 3-Voltmeter and 3-Ammeter methods in a single phase Circuit.** |

| |
|---|
| **TASK - 7 - Measurement to Real and Reactive Power in a three phase circuit.** |
| **TASK - 8 - Extension of range of given Ammeter and Voltmeter.** |
| **TASK - 9 - Measurement of displacement using LVDT.** |
| **TASK - 10 - Study of CRO: Measurement of voltage, current, frequency using lissajous patterns.** |
| **TASK - 11 - Measurement of different ranges of temperatures using i)RTD ii)Thermocouple** |
| **TASK - 12 - Measurement of strain with the help of strain gauge transducers** |
| **Additional Experiments:**<br>Measurement of 3-phase power with single wattmeter and 2 No's CT |
| **Text Book(s):**<br>http://www.acadmix.com/eBooks_Download |
| **Reference Book(s):**<br>1. http://sreevahini.edu.in/pdf/electrical-measurements-lab.pdf<br>2. http://www.eee.griet.ac.in/wp-content/uploads/2014/12/EMI-Lab-Manual.pdf |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | APPLICATIONS OF SOFT COMPUTING TOOLS IN ELECTRICAL ENGINEERING (SEC) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| II | 0 | 1 | 2 | 54 | 2 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** The objectives of this course include:

1. Understand the basic concepts of Electrical Engineering.
2. Apply the concepts to design MATLAB models.
3. Analyse various Electrical engineering applications through MATLAB.
4. Develop real time models using MATLAB.

**Course Outcomes**: At the end of the course the student will be able to

| | |
|---|---|
| **CO 1** | Understand the basic concepts of Electrical Engineering. -L2 |
| **CO 2** | Apply the concepts to design MATLAB models. -L4 |
| **CO 3** | Analyze various Electrical engineering applications through MATLAB. L3 |
| **CO 4** | Develop real time models using MATLAB. -L5 |
| **CO 5** | Design virtual PMU -L5 |

**CO-PO & PSO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | | 2 | 2 | 3 |
| **CO2** | 3 | 2 | 2 | 2 | 3 | | | | | 1 | | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | | | | | 1 | 1 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | | | | 1 | 2 | 1 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | | | | 1 | 2 | 1 | 3 | 2 | 3 |

1 – Low Level; 2 – Moderate Level; 3 – High Level

**Theory:** MATLAB-Introduction, different tool boxes, creation of program files, creation of simulink files, GUI, commonly used blocks, Simpower system toolbox, control system toolbox, Sim Drive lines, Creation of functions, Project implementation through MATLAB

**Any 10 of the following experiments are to be conducted:**

| |
|---|
| **TASK - 1 - Transient analysis of given electrical network** |
| **TASK - 2 - Simulation of 1-phase and 3-phase transformers** |
| **TASK - 3 - Study of the dynamics of second order system** |
| **TASK – 4 - Implementation of buck and boost dc-dc converters** |
| **TASK - 5 - Study on the design of PI controllers and stability analysis for a DC-DC buck Converter** |
| **TASK – 6 - Sine-PWM techniques for single-phase half-bridge, full-bridge and three-phase inverters** |
| **TASK - 7 - Economic Load Dispatch of (i) Thermal Units and (ii) Thermal Plants using** |

**Conventional method**

**TASK - 8 - Transient Stability Analysis of Power Systems using Equal Area Criterion (EAC)**

**TASK - 9 - Reactive Power Control in a transmission system (Ferranti effect, Effect of shunt Inductor)**

**TASK - 10 - Fault studies using Zbus matrix**

**TASK - 11 - Design of virtual PMU**

**TASK - 12 - Wide area control of Two area Kundur system**

**Text Book(s):**

1. **"MATLAB for Engineers"**
   *By: Holly Moore*
   - Pearson Education
   - Covers foundational to advanced MATLAB usage, relevant for electrical applications.
2. **"MATLAB/Simulink for Power System Simulation"**
   *By: Bibhu Prasad Ganthia*
   - BPB Publications
   - Tailored for electrical machines, power systems, and control applications.
3. **"Simulation of Power Electronics Converters Using MATLAB-Simulink"**
   *By: Venkata Dinavahi*
   - Springer
   - Real-time modeling and simulation of converters and drives.
4. **"Soft Computing with MATLAB Programming"**
   *By: N.P. Padhy, S. Simon*
   - Oxford University Press
   - Covers fuzzy logic, neural networks, and evolutionary algorithms with MATLAB.
5. **"Soft Computing and Intelligent Systems Design"**
   *By: F. O. Karry and C. de Silva*
   - Pearson
   - Excellent resource for AI/ML, fuzzy, ANN, GA with practical applications.
6. **"Artificial Intelligence Techniques in Power Systems"**
   *By: Kevin Warwick, Arthur Ekwue, Raj Aggarwal*
   - Institution of Engineering and Technology (IET)
   - Discusses AI/soft computing tools specifically applied to power systems.

**Reference Book(s):**

1. **"Phasor Measurement Units and Wide Area Monitoring Systems"**
   *By: Arun Phadke, James Thorp*
   a. Springer
   b. Best for understanding PMU design, architecture, and grid integration.
2. **"Power System Analysis with Design Applications"**
   *By: J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma*
   a. Cengage Learning
   b. Useful for modeling and system-level analysis with PMU applications.

**Online Learning Resources/Virtual Labs:**

1. http://vem-iitg.vlabs.ac.in/
2. https://vp-dei.vlabs.ac.in/Dreamweaver/

SEMESTER VII (4th Year, 1st Semester)

| Course Code | Category | Course Title | Contact Periods perweek | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| | PC | Power System Operation and Control | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | MC-II | 1. Business Ethics and Corporative Governance<br>2. E-Business<br>3. Management Science | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | PE-IV | Professional Elective – IV | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | PE-V | Professional Elective - V | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | OE-III | Open Elective - III | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | OE-IV | Open Elective - IV | 3 | 0 | 0 | 3 | 3 | 30 | 70 | 100 |
| | SEC | Power Systems and Simulation Lab | 0 | 0 | 4 | 4 | 2 | 30 | 70 | 100 |
| | AC | Gender Sensitization | 2 | 0 | 0 | 2 | 0 | -- | 100 | 100 |
| | | Counseling / Mentoring | 0 | 0 | 1 | 1 | 0 | -- | -- | -- |
| | | Sports/Hobby Clubs/Activities | 0 | 0 | 2 | 2 | 0 | -- | -- | -- |
| | Internship | Evaluation of Industry Internship | 0 | 0 | 0 | 0 | 2 | -- | -- | -- |
| | | Activity PointProgramme | During the Semester | | | | | 20 Points | | |
| | | **Total** | **20** | **00** | **9** | **29** | **22** | **270** | **730** | **1000** |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | POWER SYSTEM OPERATION AND CONTROL | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** The objectives of the course are to make the students learn about

1. Optimal Operation of Thermal Power Stations.
2. Hydrothermal Scheduling.
3. Modelling of Turbines and Generators.
4. Load frequency control of Single Area and Two Area Systems.
5. The Shunt and Series Reactive Power Compensations in Power Systems.
6. The Key Aspects of Power System Deregulation.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | To Understand the Thermal Station Characteristics and Economic Dispatch Problem of Thermal Units and Understand the Optimal Scheduling of Hydro-Thermal Station with minimization of cost of Thermal station– L3. |
| **CO 2** | To Develop the First Order Models of Turbine, Governor and Generator Load Model – L4. |
| **CO 3** | To Evaluate the Steady State & Dynamic Analysis of Single Area and Two Area Load Frequency Control – L3. |
| **CO 4** | To Analyse the Series & Shunt Reactive Power Compensation in Transmission and Load Systems – L3. |
| **CO 5** | To Understand the Aspects of Power System Deregulation – L2. |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 1 | 2 | 2 | | 2 | | | | | | | | 3 | 2 |
| CO2 | 2 | 2 | 2 | | 2 | | | | | | | | 3 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 2 |
| CO5 | 2 | 2 | 2 | | 2 | | | | | | | | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Optimum Operation of Thermal Power Station

Heat Rate Curve – Cost Curve – Incremental Fuel Rate – Incremental Fuel Cost and Production Cost, Input – Output Characteristics of Thermal Power Stations and Hydro Power Stations. Optimum Generation Allocation of Thermal Units without Transmission Line Losses and Optimum Generation Allocation with effect of Transmission Line Losses. Transmission Line Loss Formula, Loss coefficients, Numerical Problems.

### MODULE -2: Economic Operation of Hydro – Thermal Scheduling

**Optimum Operation of Hydrothermal Power Stations:** Hydrothermal Coordination Methods – Optimal power flow problem formulation for loss and cost minimization, Solution of optimal power flow problem using Newton‘s method and Linear Programming technique – Numerical problems.

| MODULE-3: Load Frequency Control |
|---|
| **Modeling of Turbine & Governor:** The first order Turbine model, Block Diagram representation of Steam Turbines and approximate Linear models, Mathematical Modelling of Speed Governing Systems – Derivation of small Signal Transfer function – Block Diagram.<br>**Single Area Load Frequency Control:** Necessity of Keeping Frequency constant, Definition of Control Area – Single Area Control – Block Diagram representation of an Isolated Power System – Steady State Analysis – Dynamic Response – Controlled & Uncontrolled case.<br>**Two Area Load Frequency Control:** Load Frequency control of Two Area system – Controlled and Uncontrolled case, Tie – Line Bias Control. Proportional Plus Integral Control of Single Area and Its Block Diagram Representation, Steady State Response – Load Frequency Control and Economic Dispatch Control. |
| **MODULE-4: Reactive Power Control** |
| Overview of Reactive Power Control – Reactive Power Compensation in Transmission Systems – Advantages and Disadvantages of Different Types of Compensating Equipment for Transmission Systems; Load Compensation – Specifications of Load Compensator, Uncompensated and Compensated Transmission Lines: Shunt and Series Compensation. |
| **MODULE-5: Power System Deregulation** |
| Principle of economics, utility functions, power exchanges, electricity market models, market power indices, ancillary services, transmission and distribution charges, principles of transmission charges, transmission pricing methods, demand-side management, regulatory framework – Numerical problems. |
| **Total hours:** 54 |

**Term work:**

Field work of power system operation & Deregulation in Thermal power plant

**Content beyond syllabus:**

Knowledge of Voltage control in Power systems

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Economic Operationof Thermal power Station | CO1 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |
| 2 | Hydro thermal Scheduling | CO2 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |
| 3 | Load frequency single area control | CO3 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |
| 4 | Load frequency two area control | CO4 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |
| 5 | Deregulation of Power System | CO5 | http://175.101.102.82/moodle/mod/folder/view.php?id=13928 |

**Text Book(s):**

1. Modern Power System Analysis, D.P.Kothari and I.J.Nagrath, Tata McGraw Hill Publishing Company Ltd.,
2. Electric Energy Systems Theory: An Introduction, Olle I. Elgerd, TMH Publishing Company Ltd., New Delhi, 2nd edition, 1983.

**Reference Book(s):**

1. Power Generation, Operation and Control, Allen J. Wood and Bruce F. Wollenberg, John Wiley & Sons, Inc., New York, 2nd edition, 1996.
2. Reactive Power Control in Electric Systems, T J E Miller, John Wiley & Sons, New York, 1982.
3. Power System Analysis Operation and Control, Abhijit Chakrabarti and Sunita Halder, PHI Learning Pvt. Ltd.,, 3rd Edition, 2010.

**Online Resources:**

1. https://archive.nptel.ac.in/courses/108/104/108104052/
2. http://kcl.digimat.in/nptel/courses/video/108104191/L01.html
3. https://nptel.ac.in/courses/108101040

**Web Resources:**

1. http://175.101.102.82/moodle/course/view.php?id=610
2. http://www.acadmix.com/eBooks_Download
3. http://175.101.102.82/moodle/course/view.php?id=610
4. https://lecturenotes.in/notes/14667-note-for-power-system-operation-and-control-psoc-by-jntu-heroes?reading=true&continue=2
5. https://lecturenotes.in/notes/17488-note-for-power-system-operation-and-control-psoc-by-sucharita-das
6. http://www.crectirupati.com/sites/default/files/lecture_notes/PSOC%20-%20%20IV%20-%21EEE_0.pdf
7. http://www.tutorialspoint.com/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | POWER SYSTEMS AND SIMULATION LAB | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | CS | TOTAL |
| I | 0 | 0 | 4 | 72 | 2 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** The objectives of this course include

1. To do the experiments (in machines lab) on various power system concepts like determination of sequence impedance, fault analysis, finding of subtransient reactance's.
2. To draw the equivalent circuit of three winding transformer by conducting a suitable experiment.
3. To develop the MATLAB program for formation of Y and Z buses. To develop the MATLAB programs for Gauss-Seidel and fast decoupled load flow studies.
4. To develop the SIMULINK model for single area load frequency problem.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Analyze and determine the sequence impedances of both cylindrical rotor and salient pole synchronous machines to understand their behavior under various fault conditions. -L3 |
| **CO 2** | Conduct fault analysis (LG, LL, LLG, and LLLG) on synchronous machines and interpret the impact of these faults on system stability and performance. -L2 |
| **CO 3** | Develop and simulate load flow analysis using various methods (Gauss-Seidel, Newton-Raphson, Fast Decoupled) and formulate the YBus and ZBus for power system networks. -L5 |
| **CO 4** | Model load frequency control problems for single and two-area systems, employing both uncontrolled and PI-controlled approaches to evaluate system performance.- L4 |
| **CO 5** | Simulate load frequency control problems for single and two-area systems, employing both uncontrolled and PI-controlled approaches to evaluate system performance.-L6 |

**CO-PO & PSO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 2 | | | | 2 | 2 | | 1 | 2 | 3 |
| **CO2** | 2 | 2 | 1 | 1 | 2 | | | | 2 | 2 | | 1 | 2 | 3 |
| **CO3** | 2 | 2 | 1 | 1 | 2 | | | | 2 | 2 | | 1 | 1 | 3 |
| **CO4** | 2 | 2 | 1 | 1 | 2 | | | | 2 | 2 | | 1 | 1 | 3 |
| **CO5** | 2 | 2 | 1 | 1 | 2 | | | | 2 | 2 | | 1 | 1 | 3 |

1 – Low Level; 2 – Moderate Level; 3 – High Level

## List of Experiments

**Any 10 of the following experiments are to be conducted:**

| |
|---|
| **TASK - 1 - Determination of Sequence Impedances of Cylindrical Rotor Synchronous Machine** |
| **TASK - 2 - Determination of Sequence Impedances of salient pole Synchronous Machine** |

**TASK - 3 - LG Fault Analysis on an un loaded alternator**

**TASK – 4 - LL Fault Analysis on conventional phases**

**TASK - 5 - LLG Fault Analysis**

**TASK – 6 - LLLG Fault Analysis**

**TASK - 7 - Determination of Sub transient reactance of salient pole synchronous machine**

**TASK - 8 - Equivalent circuit of three winding transformer.**

**TASK - 9 - YBus formation using Soft Tools**

**TASK - 10 - ZBus formation using Soft Tools**

**TASK - 11 - Gauss-Seidel load flow analysis using Soft Tools**

**TASK - 12 - Newton-Raphson load flow analysis using Soft Tools**

**TASK – 13 - Fast decoupled load flow analysis using Soft Tools**

**TASK – 14 - Solve the Swing equation and Plot the swing curve**

**TASK – 15 - Develop a model for a uncontrolled single area load frequency control problem and simulate the same using Soft Tools.**

**TASK – 16 - Develop a model for PI controlled single area load frequency control problem and simulate the same using Soft Tools.**

**TASK – 17 - Develop a model for a uncontrolled two area load frequency control problem and simulate the same using Soft Tools.**

**TASK – 18 - Develop a model for PI controlled two area load frequency control problem and simulate the same using Soft Tools.**

**Additional Experiments:**

1. Design of kalman filter
2. MATLAB program to find optimum loading ofgenerators neglecting transmission losses

**Text Book(s):**


1. POWER SYSTEM ANALYSIS – by – HADI SAADAT - Tata McGraw-Hill Education, 01-Aug-2002.
2. MATLAB for Electrical Engineers and Technologists: MATLAB Tutorial with Practical Electrical Examples- Stephen P. Tubbs, 2010


**Reference Book(s):**


1. Power Systems Analysis, Grainger and Stevenson, Tata Mc Graw-hill, 2005.
2. Modern Power system Analysis 2nd edition, I.J.Nagrath & D.P.Kothari: Tata McGraw- Hill Publishing Company, 2003.
3. Kundur, P., “Power System Stability and Control”, Mc. Graw Hill inc. 1994.
4. Jim Arlow, Ila Neustadt, “UML 2 and the Unified Process: Practical Object-Oriented
5. Analysis and Design”, 2nd Edition, Pearson, (2005).

**Online Learning Resource:**

1. https://www.ee.iitb.ac.in/~vlabsync/template/vlab/index.html#
2. http://www.academia.edu/Documents/in/Power-System-Analysis-by-Hadi-Saadat-Electrical- Engineering
3. https://nptel.ac.in/courses/108/101/108101040/
4. https://nptel.ac.in/courses/108/104/108104052/
5. https://nptel.ac.in/courses/108/105/108105067/

SEMESTER VIII (4th Year, 2nd Semester)

| Course Code | Category | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| | PR | Internship and Project | -- | -- | 24 | 24 | 12 | 60 | 140 | 200 |

# DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
## Regulation: NECR B.TECH 23

## HONOURS IN ELECTRIC VEHICLES

A student shall earn additional 18 credits for award of B.Tech. (Honours) degree from same branch/department/discipline registered for major degree. This is in addition to the credits essential for obtaining the Undergraduate degree in Major Discipline (i.e., 160 credits).

| S. No. | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | | E - Mobility | 3 | 0 | 0 | 3 |
| 2 | | Battery Management Systems | 3 | 0 | 0 | 3 |
| 3 | | Special Machines for Electric Vehicles | 3 | 0 | 0 | 3 |
| 4 | | Grid Interface of Electric Vehicles | 3 | 0 | 0 | 3 |
| 5 | | EV Charging Technologies | 3 | 0 | 0 | 3 |
| 6 | | Project on Electric Vehicles | 0 | 0 | 6 | 3 |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | E - MOBILITY | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. Understand the fundamental concepts and principles of Electric vehicles
2. Apply the concepts to implement battery technology
3. Apply the concepts to implement charging technology
4. Understand the future trends in EVs

**Course Outcomes**: The students will be able to

| | |
|---|---|
| **CO 1** | Understanding the Fundamentals of Electric Vehicles and Vehicle Dynamics. Choose suitable motors and analyse different power electronics in EVs. -L2 |
| **CO 2** | Analyzing Battery Technologies for Electric Vehicles. -L4 |
| **CO 3** | Understanding and Evaluating Charging Technologies for Electric Vehicles. -L2 |
| **CO 4** | Exploring Future Trends and Innovations in Electric Vehicles.-L5 |
| **CO 5** | Understanding E-Mobility, Policy, and Integration with Smart Grids. -L2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 3 | 2 | 3 | | 2 | | 1 | 1 | 1 | 3 | | |
| CO2 | 3 | 3 | 2 | 2 | 3 | | 2 | | | 1 | 1 | 2 | | |
| CO3 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | | | 1 | 1 | 2 | | |
| CO4 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 3 | | |
| CO5 | 2 | 2 | 2 | | | | | | | | | | | |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction

Introduction to electric vehicles: EV verses gasoline vehicles, vehicle dynamics fundamentals, e- drivetrain, Electric motor, Power electronic in electric vehicles, Regenerative braking.

### MODULE -2: Battery Technology

Battery Technology for EVs: Storage technologies for EV, Battery working principles, Battery losses, Li-ion batteries, Battery pack and battery management system.

### MODULE-3: Charging Technology

Charging Technology of EVs: AC charging - Type 1,2,3, DC charging, Fast charging and its limitations, Smart charging and applications, Vehicle to X(V2X), X2V technology.

### MODULE-4: FUTURE TRENDS IN EVs

Future trends in e-Vehicles: Wireless charging of EV, On-road charging of EV, Battery swap technology, Solar powered EVs, Charging EVs from renewables.

### MODULE-5: E-Mobility

| | |
|---|---|
| E-mobility: electrification challenges, business, connected mobility and autonomous mobility case study in Indian Roadmap Perspective, Policy- EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. | |
| **Total hours:** | 54 |

**Term work:**
Survey report on E-bike usage

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | EV verses gasoline vehicles | CO1 | https://www.nrdc.org/stories/electric-vs-gas-cars-it-cheaper-drive-ev |
| 2 | Storage technologies for EV | CO2 | https://www.sciencedirect.com/science/article/pii/S2095756420300647 |
| 3 | Fast charging and its limitations | CO3 | https://renewablesadvice.com/battery/ev-fast-charging/ |
| 4 | Wireless charging of EV | CO4 | https://www.slideshare.net/slideshow/pritam-kumar-singh-75773232/75773232 |
| 5 | Electrification challenges | CO5 | https://www.automotive-technology.com/articles/electrification-drive-advancements-and-challenges-in-electric-vehicles |

**Text Book(s):**
1. Iqbal Hussain, ―Electric & Hybrid Vehicles – Design Fundamentals‖, Second Edition, CRC Press, 2011.
2. James Larminie, ―Electric Vehicle Technology Explained‖, John Wiley & Sons, 2003.

**Reference Book(s):**
1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, ―Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals‖, CRC Press, 2010.
2. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.
3. Sandeep Dhameja, ―Electric Vehicle Battery Systems‖, Newnes, 2000
4. Tariq Muneer and Irene Illescas García, ―The automobile, In Electric Vehicles: Prospects and Challenges‖, Elsevier, 2017.

**Online Resources:**
https://nptel.ac.in/courses/108106170

**Web Resources:**
https://www.emobility-engineering.com/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BATTERY MANAGEMENT SYSTEMS | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. Understand the basics of batteries and its parameters
2. Apply the concepts to create Battery Management System
3. Create Physical and Simulation models for Battery Management System
4. Design different Battery Management Systems

**Course Outcomes**: After completion of this course, student will be able to

| | |
|---|---|
| **CO 1** | Understand the role of battery management system -L2 |
| **CO 2** | Identify the requirements of Battery Management System. L2 |
| **CO 3** | Interpret the concept associated with battery charging / discharging process.-L3 |
| **CO 4** | Analyze various parameters of battery and battery pack. L4 |
| **CO 5** | Design the model of battery pack. L5 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | | | 2 | 1 | 2 | | | | | 2 | | |
| CO2 | 3 | 2 | 2 | | 2 | 1 | 2 | | | 1 | | 2 | | |
| CO3 | 3 | 3 | 2 | 2 | 3 | | | | | 1 | 1 | 2 | | |
| CO4 | 3 | 3 | 3 | 2 | 3 | | 2 | | | 1 | 1 | 2 | | |
| CO5 | 3 | 3 | 3 | 2 | 3 | | 2 | | 1 | 2 | 2 | 3 | | |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction

Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging

### MODULE -2: Battery Management System

Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation, Cell total energy and cell total power

### MODULE-3: Battery State Of Charge And State Of Health Estimation

Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing

### MODULE-4: Modelling and Simulation

| |
|---|
| Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs |
| **MODULE-5: Design Of Battery Management Systems** |
| Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system |
| **Total hours:** 54 |

**Term work:**
Report submission on different types of batteries and their usage

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Cells connected in series, Cells connected in parallel | CO1 | https://www.geeksforgeeks.org/physics/combination-of-cells-in-series-and-parallel/ |
| 2 | Battery pack topology | CO2 | https://tritekbattery.com/3-topologies-of-battery-management-system/ |
| 3 | Voltage-based methods to estimate SOC | CO3 | https://www.batterydesign.net/soc-estimation-techniques/ |
| 4 | Simulating an electric vehicle | CO4 | https://pulseenergy.io/blog/electric-vehicle-simulation-software |
| 5 | Design principles of battery BMS | CO5 | https://www.monolithicpower.com/en/learning/resources/how-to-design-a-battery-management-system-bms?srsltid=AfmBOoppjr-erTC51gzOrr-IvBG4978GCIo-Yif6Vc7AxVNIPax_T-fM |

**Text Book(s):**

1. Plett, Gregory L. Battery management systems, Volume I: Battery modelling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.

**Reference Book(s):**

1. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L ―Battery Management Systems -Design by Modelling‖ Philips Research Book Series 2002.
2. Davide Andrea,‖ Battery Management Systems for Large Lithium-ion Battery Packs‖ Artech House, 2010
3. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

**Online Resources:**

https://www.sciencedirect.com/topics/engineering/battery-management-system

**Web Resources:**

https://www.cyient.com/blog/battery-management-system-in-electric-vehicles

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SPECIAL MACHINES FOR ELECTRIC VEHICLES | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. Understand various Motor Drives useful for EV applications
2. Apply the concepts to implement various designs
3. Analyze performance of various Motor Drives
4. Evaluate the usage of specific drive for EV application

**Course Outcomes**: After completion of this course, student will be able to

| | |
|---|---|
| **CO 1** | Understanding the Fundamentals of Permanent Magnet (PM) Brushless Motor Drives. -L2 |
| **CO 2** | Analyzing Switched Reluctance Motor (SRM) Drives. -L4 |
| **CO 3** | Evaluating Stator-Permanent Magnet (PM) Motor Drives. -L4 |
| **CO 4** | Understanding and Designing Magnetic-Gear Motor Drives. -L2 |
| **CO 5** | Exploring Advanced Magnetless and Multiphase Motor Drives. L5 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 2 | | 3 | | | | | 1 | | 2 | | |
| CO2 | 3 | 3 | 2 | 2 | 3 | | | | | 1 | 1 | 2 | | |
| CO3 | 3 | 2 | 3 | 2 | 3 | | | | | 1 | 1 | 2 | | |
| CO4 | 3 | 3 | 3 | 2 | 3 | | 1 | | | 1 | 1 | 3 | | |
| CO5 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | | 1 | 2 | 2 | 3 | | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: Permanent Magnet (PM) Brushless Motor Drives**

Structure of PM Brushless Machines, Principle of PM Brushless Machines Modeling of PM Brushless Machines, Inverters for PM Brushless Motors Motor Control, Design Criteria of PM Brushless Motor Drives for EVs, Design Examples of PM Brushless Motor Drives for EVs, Application, Advantages and Limitations for EVs.

**MODULE -2: Switched Reluctance Motor Drive**

Structure of SR Machines, Principle of SR Machines, SR Converters Topologies, SR Motor Control, Design Criteria of SR Motor Drives for EVs, Examples of SR Motor Drives for EVs, Application, Advantages and Limitations for EVs.

**MODULE-3: Stator-PM Motor Drives**

Doubly-Salient PM Motor Drives, Flux-Reversal PM Motor Drives, Flux-Switching PM Motor Drives, Hybrid-Excited PM Motor Drives Flux-Mnemonic PM Motor Drives, Design Criteria of Stator-PM Motor Drives for EVs, Application, Advantages and Limitations for EVs.

**MODULE-4: Magnetic-Geared Motor Drives**

Principle of MG Machines, Modeling of MG Machines, Inverters for MG Motors, MG Motor Control, Design Criteria of MG Motor Drives for EVs, Application, Advantages and Limitations for EVs

**MODULE-5: Advanced Magnetless Motor Drives and Multiphase Motor Drives**

Introduction of Advanced Magnetless technology, Synchronous Reluctance Motor Drives, Doubly- Salient DC Motor Drives, Flux-Switching DC Motor Drives, Design Criteria of Advanced Magnetless Motor Drives for EVs, Application, Advantages and Limitations for EVs. Multiphase Induction Motor drives – principle, operation and control, Multiphase PMSM machine – principle, operation and control, Fault tolerant operation of multiphase drives

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**

Report submission on different types of machines using in EV's

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Inverters for PM Brushless Motors Motor Control | CO1 | https://www.orientalmotor.com/brushless-dc-motors-gear-motors/technology/brushless-dc-motors-servo-motors-inverter.html |
| 2 | Design Criteria of SR Motor Drives for EVs | CO2 | https://iopscience.iop.org/article/10.1088/1742-6596/2070/1/012140 |
| 3 | Hybrid-Excited PM Motor Drives | CO3 | https://www.mdpi.com/1996-1073/14/4/916 |
| 4 | Modeling of MG Machines | CO4 | https://www.mdpi.com/1996-1073/16/4/1852 |
| 5 | Synchronous Reluctance Motor Drives | CO5 | https://www.elprocus.com/synchronous-reluctance-motor-working/ |

**Text Book(s):**

1. Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, ―Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design‖, CRC Press, 2004.
2. James Larminie and John Loury, ―Electric Vehicle Technology – Explained‖, John Wiley & Sons
Ltd, 2003.

**Reference Book(s):**

1. Sandeep Dhameja, ―Electric Vehicle Battery Systems‖, Butterworth – Heinemann, 2002.
2. Ronald K Jurgen, ―Electric and Hybrid – Electric Vehicles‖, SAE, 2002.
3. Ron Hodkinson and John Fenton, ―Light Weight Electric/Hybrid Vehicle Design‖, Butterworth – Heinemann, 2001.
4. Iqbal Husain, ―Electric and Hybrid Vehicles- Design Fundamentals‖ CRC Press, 2011.

**Web Resources:**

https://www.mdpi.com/journal/machines/special_issues/KU5426H041

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | GRID INTERFACE OF ELECTRIC VEHICLES | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. Understand the Grid interfacing concept of EVs
2. Analyze the EV impact on grid
3. Design new types of charging facilities for EVs
4. Evaluate the role of EV as ancillary service

**Course Outcomes**: After completion of this course, student will be able to

| | |
|---|---|
| **CO 1** | Understanding the Fundamentals of Smart Grid and Electric Vehicle Integration Analyze Impact of EV on smart grid -L2 |
| **CO 2** | Analyzing the Impact of EVs and V2G on the Smart Grid and Renewable Energy Systems -L3 |
| **CO 3** | Applying Power Conversion Technologies for Smart Grids and Electric Vehicles-L4 |
| **CO 4** | Designing Control and Management Strategies for PEV Parking Lots -L5 |
| **CO 5** | Evaluating the Role of PEVs as Ancillary Services in Smart Grids -L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | | | 1 | | 3 | | |
| CO2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | | | 1 | 1 | 3 | | |
| CO3 | 3 | 2 | 3 | 2 | 3 | | | | | 1 | 1 | 2 | | |
| CO4 | 3 | 3 | 3 | 2 | 3 | | 1 | | 1 | 2 | 2 | 3 | | |
| CO5 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: Introduction to Smart Grid and PEV**

Introduction to smart grid and microgrid, Impact of PEVs on Distributed Energy Resources in the Smart Grid, V2G Technology and PEVs Charging Infrastructures

**MODULE -2: Impact of V2G and G2V on the Smart Grid and Renewable Energy Systems**

Types of Electric Vehicles, Motor Vehicle Ownership and EV Migration, Impact of Estimated EVs on Electrical Network, Impact on Drivers and the Smart Grid, Standardization and Plug-and-Play

**MODULE-3: Power Conversion Technology in the Smart Grid and EV**

Impacts of EV Penetration on Grid Power Profile, Requirements of Its Control and Monitoring, Hybrid EV Powertrain Architectures, Control, Monitoring and Management Strategies of EV, V2G Communication System, System model of EV, Case study of three phase fault and its impact

| MODULE-4: Planning, Control and Management Strategies for Parking Lots for PEVs | |
|---|---|
| Introduction to PEV Charging Facility, Long-Term Planning for PEV Parking Lots, Control and Management of PEV Parking Lots - stages of implementation | |
| **MODULE-5: PEV as Ancillary Service in Smart Grid** | |
| Introduction to Ancillary Services, PEV Charger Optimization, PEV as ancillary source, Control Strategies for PEVs to Follow the Individual Operation Values, Systems and Control Algorithm for Smart PEV Chargers, Avoiding the Harmonic Propagation Within the Grid, Case study | |
| **Total hours:** | 54 |

**Term work:**
Report submission on possibilities of grid integration.

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | V2G Technology | CO1 | https://www.evconnect.com/blog/what-is-vehicle-to-grid-for-electric-vehicles |
| 2 | Types of Electric Vehicles | CO2 | https://e-amrit.niti.gov.in/types-of-electric-vehicles |
| 3 | Impacts of EV Penetration on Grid Power Profile | CO3 | https://www.mdpi.com/2032-6653/16/5/264 |
| 4 | Long-Term Planning for PEV Parking Lots | CO4 | https://www.sciencedirect.com/science/article/abs/pii/S2352152X24036430 |
| 5 | Introduction to Ancillary Services | CO5 | https://www.drax.com/power-generation/what-are-ancillary-services/ |

**Text Book(s):**
1. Lu, J. and Hossain, J., Vehicle-to-grid: linking electric vehicles to the smart grid. Institution of Engineering and Technology, 2015.
2. Rajakaruna, S., Shahnia, F. and Ghosh, A. eds., Plug In Electric Vehicles in Smart Grids: Integration Techniques. Springer, 2014.

**Reference Book(s):**
1. Rajakaruna, S., Shahnia, F. and Ghosh, A. eds., Plug in electric vehicles in smart grids: charging strategies. Springer, 2014.
2. Salman, S.K., Introduction to the Smart Grid: Concepts, Technologies and Evolution (Vol. 94). IET., 2017.

**Web Resources:**
https://driivz.com/glossary/ev-grid-integration/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | EV CHARGING TECHNOLOGIES | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. Provide fundamental knowledge of batteries, key parameters, and battery performance characteristics in Electric Vehicles (EVs).
2. Enable students to understand and apply battery modeling and estimation techniques relevant to EV applications.
3. Familiarize students with EV charging infrastructure, protocols, grid integration, and related policy/regulatory frameworks.
4. Develop the ability to evaluate different charging techniques and their impact on battery health, performance, and energy efficiency.
5. Introduce the role of power electronic converters, control strategies, and technologies used in modern EV charging systems.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding Battery Basics and Key Parameters-L2 |
| **CO 2** | Analyzing Battery Modeling Techniques and Capacity Estimation-L3 |
| **CO 3** | Exploring Charging Infrastructure and Regulatory Frameworks-L4 |
| **CO 4** | Evaluating Battery Charging Techniques and Performance-L3 |
| **CO 5** | Understanding Power Electronics in EV Charging Systems-L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO1** | 3 | 2 | | | 2 | 1 | 2 | | | | | 2 | | |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | | 1 | 1 | 2 | | |
| **CO3** | 2 | 2 | 2 | | 2 | 2 | 2 | 1 | | 2 | 2 | 2 | | |
| **CO4** | 3 | 3 | 2 | 2 | 3 | | 1 | | | 1 | 1 | 2 | | |
| **CO5** | 3 | 2 | 3 | 2 | 3 | | | | | 1 | 1 | 2 | | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: Battery Basics**

Battery parameters- Cell and Battery Voltages, Charge (or Amp hour) Capacity, Energy Stored, Specific Energy, Energy Density, Specific Power, Amp hour (or Charge) Efficiency, Energy Efficiency, Self-discharge Rates, Battery Geometry, Battery Temperature, Heating and Cooling Needs 35 3.2.12 Battery Life and Number of Deep Cycles Types of batteries- lead-acid, nickel based sodium based, lithium batteries, metal-air batteries. Refilled Batteries

**MODULE -2: Battery Modeling**

| |
|---|
| The Purpose of Battery Modelling, Electrochemical model, black box model, equivalent circuit model - Battery Equivalent Circuit, Modelling Battery Capacity, Simulating a Battery at a Set Power, Calculating the Peukert Coefficient, Approximate Battery Sizing, Battery state of charge estimation. |
| **MODULE-3: Charging Infrastructure** |
| EV supply equipment, charging standards, classification of charging infrastructure, connecting EVs to the electricity grid, regulatory framework for EV charging connections, communication protocols for smart charging, Battery Management System. |
| **MODULE-4: Battery Charging Techniques** |
| Basic Terms for Evaluating Charging Performances, Charging Algorithms for Li-Ion Batteries, Optimal Charging Current Profiles for Lithium-Ion battery, Lithium Titanate Oxide Battery with Extreme Fast Charging Capability. Super Capacitors for battery charging. |
| **MODULE-5: Power Electronics in EV Charging** |
| Active front end rectifiers - Forward converters, half and full bridge DC-DC converters, power factor correction converters, decreasing impact on the grid and switches, bidirectional battery chargers, wireless charging |

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**
Report submission on EV charging technologies

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Self-discharge Rates | CO1 | https://en.wikipedia.org/wiki/Self-discharge |
| 2 | The Purpose of Battery Modelling | CO2 | https://www.monolithicpower.com/en/learning/mpscholar/battery-management-systems/battery-modeling/significance-of-battery-modeling?srsltid=AfmBOorUPv5dvPa4XCBD6rYUnPmc6B_92MA1mzNdui0VuOirR9U2RnIL |
| 3 | Classification of charging infrastructure | CO3 | https://www.gridenpower.com/3-classifications-of-ev-charging-infrastructure-you-should-know-about.php |
| 4 | Basic Terms for Evaluating Charging Performances | CO4 | https://www.qeios.com/read/JHM4V3 |
| 5 | Half and full bridge DC-DC converters | CO5 | https://testbook.com/electrical-engineering/half-bridge-converter |

**Text Book(s):**
1. James Larminie, John Lowry, ―Electric Vehicle Technology Explained‖, Wiley, 2012.
2. RuiXiong, Weixiang Shen, ―Advanced Battery management Technologies for Electric Vehicle‖, Wiley, 2018

**Reference Book(s):**

1. Handbook of Electric Vehicle Charging Infrastructure Implementation, NITI Aayog, Government of India.
2. Chris Mi, M. AbulMasrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Wiley, 2017
3. Bruno Scrosati, Jurgen Garche, Werner Tillmetz, Advances in Battery Technologies for Electric Vehicles, Wood head Publishing Series in Energy, 2015
4. Sheldon S. Williamson , Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013

**Web Resources:**

https://pulseenergy.io/blog/ev-charging-technology

# DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
## Regulation: NECR B.TECH 23

### List of PROFESSIONAL ELECTIVES

**From JNTUA for R23:**

| S. No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | PE-I | | 1. Signals and Systems | 3 | 0 | 0 | 3 |
| 2 | | | 2. Electrical Safety and Risk Management | 3 | 0 | 0 | 3 |
| 3 | | | 3. Utilization of Electrical Energy | 3 | 0 | 0 | 3 |
| 4 | PE-II | | 1. Switchgear and Protection | 3 | 0 | 0 | 3 |
| 5 | | | 2. AI & ML for Electrical Engineering | 3 | 0 | 0 | 3 |
| 6 | | | 3. Programmable Logic Controllers | 3 | 0 | 0 | 3 |
| 7 | PE-III | | 1. Electric Drives | 3 | 0 | 0 | 3 |
| 8 | | | 2. Communication Systems | 3 | 0 | 0 | 3 |
| 9 | | | 3. Renewable and Distributed Energy Technologies | 3 | 0 | 0 | 3 |
| 10 | PE-IV | | 1. Digital Signal Processing | 3 | 0 | 0 | 3 |
| 11 | | | 2. HVDC & FACTS | 3 | 0 | 0 | 3 |
| 12 | | | 3. Electric Vehicle Technology | 3 | 0 | 0 | 3 |
| 13 | PE-V | | 1. Modern Control Theory | 3 | 0 | 0 | 3 |
| 14 | | | 2. Switched Mode Power Conversion | 3 | 0 | 0 | 3 |
| 15 | | | 3. Electrical Distribution System | 3 | 0 | 0 | 3 |

### PROFESSIONAL ELECTIVES - I (Comparative Table)

| S. No. | Proposed list by JNTUA | Recommended list by NECG | NECG R21 |
|---|---|---|---|
| 1 | Signals and Systems | Signals and Systems | Industrial Electrical Systems |
| 2 | Electrical Safety and Risk Management | Electrical Safety and Risk Management | System Modeling and Identification |
| 3 | Utilization of Electrical Energy | Utilization of Electrical Energy | Machine Modeling and Analysis |
| 4 | | Machine Modeling and Analysis | Renewable Energy Conversion Systems |
| 5 | | Advanced Power SemiconductorDevices and Protection | Advanced Power Electronics |

## PROFESSIONAL ELECTIVES - II (Comparative Table)

| S. No. | Proposed list by JNTUA | Recommended list by NECG | NECG R21 |
|---|---|---|---|
| 1 | Switchgear and Protection | Switchgear and Protection | Power System Planning |
| 2 | AI & ML for Electrical Engineering | AI & ML for Electrical Engineering | Advanced Control systems |
| 3 | Programmable Logic Controllers | Programmable Logic Controllers | Electrical Machine Design |
| 4 | | Electrical Machine Design | Solar and Fuel Cell Energy Systems |
| 5 | | Solar and Fuel Cell Energy Systems | Advanced Electrical Drives |

## PROFESSIONAL ELECTIVES - III (Comparative Table)

| S. No. | Proposed list by JNTUA | Recommended list by NECG | NECG R21 |
|---|---|---|---|
| 1 | Electric Drives | Electric Drives | Reactive Power Compensation and Management |
| 2 | Communication Systems | Communication Systems | Digital Signal Processing |
| 3 | Renewable and Distributed Energy Technologies | Renewable and Distributed Energy Technologies | Programmable Control Devices and Applications |
| 4 | | ProgrammableControl Devices and Applications | Wind and Biomass Energy Systems |
| 5 | | Wind and Biomass Energy Systems | HVDC and FACTS |

## PROFESSIONAL ELECTIVES - IV (Comparative Table)

| S. No. | Proposed list by JNTUA | Recommended list by NECG | NECG R21 |
|---|---|---|---|
| 1 | Digital Signal Processing | Digital Signal Processing | Power Quality |
| 2 | HVDC & FACTS | HVDC & FACTS | Multivariable Control System |
| 3 | Electric Vehicle Technology | Electric Vehicle Technology | Hybrid Electrical Vehicles |
| 4 | | Hybrid Electrical Vehicles | Utilization of Electrical Energy |
| 5 | | Renewable Energy Conversion Systems | Advanced Power Converters |

## PROFESSIONAL ELECTIVES - V (Comparative Table)

| S. No. | Proposed list by JNTUA | Recommended list by NECG | NECG R21 |
|---|---|---|---|
| 1 | Modern Control Theory | Modern Control Theory | Smart Grid Technologies |
| 2 | Switched Mode Power Conversion | Switched Mode Power Conversion | Real Time Control System |
| 3 | Electrical Distribution System | Electrical Distribution System | Automotive Electrical Engineering |
| 4 | | AutomotiveElectrical Engineering | Energy Audit and Demand side Management |
| 5 | | Energy Auditand Demand Side Management | Advanced Power Semiconductor Devices and Protection |

## PROFESSIONAL ELECTIVES

**From NECG(A) for R23:**

| Elective Track / Group | Professional Elective-1 | Professional Elective-2 | Professional Elective-3 | Professional Elective-4 | Professional Elective-5 |
|---|---|---|---|---|---|
| **Modern Power Systems** | Electrical Safety and Risk Management | Switchgear and Protection | Renewable and Distributed Energy Technologies | HVDC and FACTS | Electrical Distribution System |
| **Industrial Automation** | Signals and Systems | Programmable Logic Controllers | Communication Systems | Digital Signal Processing | Modern Control Theory |
| **Green Technology** | Utilization of Electrical Energy | AI & ML for Electrical Engineering | Electrical Drives | Electric Vehicle Technology | Switched Mode Power Conversion |
| **Modern Electrical Engineering** | Machine Modeling and Analysis | Electrical Machine Design | Programmable Control Devices and Applications | Hybrid Electrical Vehicles | Automotive Electrical Engineering |
| **Sustainable Energy Systems** | Advanced Power Semiconductor Devices and Protection | Solar and Fuel Cell Energy Systems | Wind andBiomass Energy Systems | Renewable Energy Conversion Systems | Energy Audit and Demand Side Management |

## List of PROFESSIONAL ELECTIVES

| S. No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | PE-I | | 1. Signals and Systems | 3 | 0 | 0 | 3 |
| 2 | | | 2. Electrical Safety and Risk Management | 3 | 0 | 0 | 3 |
| 3 | | | 3. Utilization of Electrical Energy | 3 | 0 | 0 | 3 |
| 4 | | | 4. Machine Modeling and Analysis | 3 | 0 | 0 | 3 |
| 5 | | | 5. Advanced Power Semiconductor Devices and Protection | 3 | 0 | 0 | 3 |
| 6 | PE-II | | 1. Switchgear and Protection | 3 | 0 | 0 | 3 |
| 7 | | | 2. Programmable Logic Controllers | 3 | 0 | 0 | 3 |
| 8 | | | 3. AI & ML for Electrical Engineering | 3 | 0 | 0 | 3 |
| 9 | | | 4. Electrical Machine Design | 3 | 0 | 0 | 3 |
| 10 | | | 5. Solar and Fuel Cell Energy Systems | 3 | 0 | 0 | 3 |
| 11 | PE-III | | 1. Electric Drives | 3 | 0 | 0 | 3 |
| 12 | | | 2. Communication Systems | 3 | 0 | 0 | 3 |
| 13 | | | 3. Renewable and Distributed Energy Technologies | 3 | 0 | 0 | 3 |
| 14 | | | 4. ProgrammableControl Devices and Applications | 3 | 0 | 0 | 3 |
| 15 | | | 5. Wind andBiomass Energy Systems | 3 | 0 | 0 | 3 |
| 16 | PE-IV | | 1. Digital Signal Processing | 3 | 0 | 0 | 3 |
| 17 | | | 2. HVDC & FACTS | 3 | 0 | 0 | 3 |
| 18 | | | 3. Electric Vehicle Technology | 3 | 0 | 0 | 3 |
| 19 | | | 4. Hybrid Electrical Vehicles | 3 | 0 | 0 | 3 |
| 20 | | | 5. RenewableEnergy Conversion Systems | 3 | 0 | 0 | 3 |
| 21 | PE-V | | 1. Modern Control Theory | 3 | 0 | 0 | 3 |
| 22 | | | 2. Switched Mode Power Conversion | 3 | 0 | 0 | 3 |
| 23 | | | 3. Electrical Distribution System | 3 | 0 | 0 | 3 |
| 24 | | | 4. Automotive Electrical Engineering | 3 | 0 | 0 | 3 |
| 25 | | | 5. Energy Audit and Demand Side Management | 3 | 0 | 0 | 3 |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | SIGNALS AND SYSTEMS (PE-I) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To understand the basic properties of signal & systems and LTI systems.
2. To learn Fourier series representation of periodic signals.
3. To study representation of signals in continuous and discrete time Fourier transform
4. To analyze the sampling theorem and characterize signals & systems in time & frequency domain.
5. To apply Laplace transform and Z transform to study about the stability of systems.

**Course Outcomes**: At the end of this course, the students will be able to

| | |
|---|---|
| **CO 1** | Explain the basic properties of signal & systems and LTI systems. L2 |
| **CO 2** | Apply Fourier series to represent periodic signals. L3 |
| **CO 3** | Represent signals in continuous and discrete time Fourier transform. L2 |
| **CO 4** | Analyze the sampling theorem and characterize signals & systems in time & frequency domain. L3 |
| **CO 5** | Analyse the stability of systems by applying Laplace transform and Z transform. L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | | | | | | | | | | | 2 | 2 |
| CO2 | 3 | 3 | | | 2 | | | | | | | | 2 | 2 |
| CO3 | 3 | 3 | | 2 | 2 | | | | | | | | 2 | 2 |
| CO4 | 3 | 3 | | 2 | 2 | | | | | | | | 2 | 2 |
| CO5 | 3 | 3 | | 3 | 2 | | | | | | | | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Signals and Systems

Continuous and Discrete Time Signals, Transformations of the Independent Variable, Elementary Signals-Unit Impulse, Unit Step Functions, Ramp Signal, Rectangular function, Signum Function, Sinc & Sa Function, Exponential and Sinusoidal Signals, Classification of Signals & Systems, Continuous and Discrete Time Systems, Basic System Properties, Linear Time Invariant (LTI) Systems, Discrete-Time LTI Systems, Convolution Sum, Continuous Time LTI Systems, Convolution Integral, Properties of LTI Systems, Causal LTI Systems described by Differential and Difference Equations, Singularity Functions.

### MODULE -2: Fourier series representation of periodic signals

Response of LTI Systems to Complex Exponentials. Fourier Series Representation of Continuous Time Periodic Signals, Trigonometric, Polar, Exponential fourier Series & related problems, Convergence of the Fourier Series, Properties of Continuous Time Fourier Series, Fourier Series Representation of Discrete Time Periodic Signals, Properties of Discrete Time Fourier Series, Fourier Series and LTI Systems

### MODULE-3: The Continuous-Time Fourier Transform

Representation of aperiodic Signals, Continuous Time Fourier Transform, Fourier Transform for Periodic Signals, Properties of the Continuous Time Fourier Transform, Systems characterized by Linear constant coefficient differential equations, Discrete Time Fourier Transform - Representation of Aperiodic Signals, Discrete Time Fourier Transform, Frequency Response, Systems Characterized by Linear Constant-Coefficient Difference Equations.

| MODULE-4: Time & Frequency Characterization of Signals and Systems | |
|---|---|
| The Magnitude Phase Representation of the Fourier Transform, Magnitude Phase Representation of the Frequency Response of LTI Systems, Time-Domain Properties of Ideal Frequency Selective Filters, Time Domain and Frequency Domain Aspects of Non-ideal Filters, Examples of Continuous time filters and Discrete time filters described by differential equations, First-Order and Second-Order Continuous and Discrete-Time Systems, Examples of Time and Frequency Domain Analysis of Systems,<br>**Sampling:** Representation of a Continuous Time Signal by Its Samples, Sampling Theorem, Reconstruction of a Signal from Its Samples Using Interpolation, Effect of under sampling: Aliasing, Discrete Time Processing of Continuous-Time Signals. | |
| **MODULE-5: Laplace and z-Transforms** | |
| The Laplace Transform, Region of Convergence for Laplace Transforms, Inverse Laplace Transform, Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot, Properties of the Laplace Transform, Some Laplace Transform Pairs, Analysis and Characterization of LTI Systems Using the Laplace Transform, System Function Algebra and Block Diagram Representations, Unilateral Laplace Transform, Z-Transform - Region of Convergence for the z-Transform, Inverse z-Transform, Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot, Properties of the z-Transform, Some Common z-Transform Pairs, Analysis and Characterization of LTI Systems Using z-Transforms, System Function Algebra and Block Diagram Representations, Unilateral z-Transforms. | |
| **Total hours:** | 54 |

**Term work:**

Mathematical analysis of any signal with any method

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Classification of Signals & Systems | CO1 | https://www.stannescet.ac.in/cms/staff/qbank/ECE/Notes/EC8352-SIGNALS%20AND%20SYSTEMS-1296919945-EC8352.pdf |
| 2 | Exponential fourier Series | CO2 | https://cpjobling.github.io/EG-247-Resources/week5/exp_fs1.pdf |
| 3 | Properties of the Continuous Time Fourier Transform | CO3 | https://www.tutorialspoint.com/properties-of-continuous-time-fourier-transform-ctft |
| 4 | Frequency Domain Aspects of Non-ideal Filters | CO4 | https://www.geeksforgeeks.org/computer-vision/frequency-domain-filters-and-its-types/ |
| 5 | System Function Algebra and Block Diagram Representations | CO5 | https://www.geeksforgeeks.org/electronics-engineering/block-diagram-algebra/ |

**Text Book(s):**

1. Signals and Systems, Alan V. Oppenheim, Alan S. Willsky, & S. Hamid, 2nd Edition, Pearson Higher Education, 1997.
2. Principles of Linear Systems and Signals, B.P. Lathi, 2nd Edition, Oxford University Press, 2011.

| |
|---|
| **Reference Book(s):**<br>1. Signals & Systems, Simon Haykin and B. Van Veen, 2nd Edition, John Wiley, 2003.<br>2. Signals and systems, Narayana Iyer and K Satya Prasad, 1st Edition, CENGAGE Learning, 2011.<br>3. Signals, Systems and Transforms, C. L. Philips, J. M. Parr and Eve A. Riskin, 4th Edition, Pearson education, 2008. |
| **Online Resources:**<br>https://www.tutorialspoint.com/dip/signals_and_system_introduction.htm |
| **Web Resources:**<br>https://vemu.org/uploads/lecture_notes/04_03_2021_1450719340.pdf |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | ELECTRICAL SAFTEY and RISK MANAGEMENT (PE-I) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. **To introduce the fundamental principles of electrical safety** and create awareness about hazards, electric shock effects, and protection strategies in electrical systems.
2. **To familiarize students with the safety requirements** during the installation, operation, and maintenance of electrical equipment and plants.
3. **To provide comprehensive knowledge of safety practices** in residential, commercial, and agricultural electrical installations.
4. **To educate learners about electrical safety in hazardous environments**, including classifications of hazardous areas and appropriate safety equipment and earthing techniques.
5. **To impart understanding of electrical safety regulations**, risk management strategies, safety audits, and compliance with Indian Electricity (IE) rules and standards.

**Course Outcomes**: At the end of the course the student shall be able to

| | |
|---|---|
| **CO 1** | Explain the objectives and precautions of Electrical Safety, effects of Shocks and their Prevention. L2 |
| **CO 2** | Summarize the Safety aspects during Installation of Plant and Equipment. L3 |
| **CO 3** | Describe the electrical safety in residential, commercial and agricultural installations. L3 |
| **CO 4** | Describe the various Electrical Safety in Hazardous Areas, Equipment Earthing and System Neutral Earthing. L3 |
| **CO 5** | State the electrical systems safety management and IE rules. L2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | | | | 2 | 2 | 2 | 3 | | 1 | | 1 | 2 | 3 | 2 |
| CO2 | 3 | 2 | 2 | | 3 | 2 | 2 | 3 | 1 | 2 | | 1 | 2 | 3 | 2 |
| CO3 | 3 | | | | 3 | 2 | 2 | 2 | | 2 | | 1 | 2 | 3 | 2 |
| CO4 | 3 | | | | 3 | 3 | 3 | 3 | | 2 | | 1 | 2 | 3 | 2 |
| CO5 | 2 | 1 | | 1 | 3 | 2 | 2 | 3 | 1 | 3 | 1 | 2 | 2 | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction to Electrical Safety, Shocks and Their Prevention

Terms and definitions, objectives of safety and security measures, Hazards associated with electric current and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over‘s, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

### MODULE -2: Safety During Installation of Plant and Equipment

Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switchyard equipment, safety during installation of electrical

rotating machines, drying out and insulation resistance measurement of rotating machines.

**MODULE-3: Electrical Safety In Residential, Commercial and Agricultural Installations**

Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do‘s and Don‘ts for safety in the use of domestic electrical appliances.

**MODULE-4: Electrical Safety in Hazardous Areas**

Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipments for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

**Equipment Earthing and System Neutral Earthing:** Introduction, Distinction between system grounding and Equipment Grounding, Equipment Earthing, Functional Requirement of earthing system, description of a earthing system, neutral grounding( System Grounding), Types of Grounding, Methods of Earthing Generators Neutrals.

**MODULE-5: Safety Management of Electrical Systems**

Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.

**Review of IE Rules and Acts and Their Significance:** Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and fire fighting facility.

The Electricity Act, 2003, (Part1, 2, 3,4 & 5)

**Total hours:** 54

**Content beyond syllabus:**

1. Arc Flash Analysis and Mitigation Techniques
2. Electrical Safety Audits and Risk Assessment Frameworks

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Possibilities of getting electrical shock | CO1 | https://www.youtube.com/watch?v=jYrOxOW71Xc |
| 2 | Field quality and safety during erection | CO2 | https://www.youtube.com/watch?v=TMT6f3tZQSk |
| 3 | Agricultural pump installation | CO3 | https://www.youtube.com/watch?v=kNRTEKzaxrs |
| 4 | Distinction between system grounding and Equipment Grounding, Equipment Earthing | CO4 | https://www.youtube.com/watch?v=PMneZbpdqng |
| 5 | Ground clearances and section clearances | CO5 | https://www.youtube.com/watch?v=wUnoTjJDHJY |

**Text Book(s):**

1. S. Rao, Prof. H.L. Saluja, ―Electrical safety, fire safety Engineering and safety management‖, Khanna Publishers. New Delhi, 1988.(units-I to V)
2. www.apeasternpower.com/downloads/elecact2003.pdf (Part of unit-V)

**Reference Book(s):**

1. Pradeep Chaturvedi, “Energy management policy, planning and utilization”, Concept Publishing company, New Delhi, 1997.

**Online Resources:**

1. https://study.com/learn/lesson/electrocution-concept-causes.html
2. https://safetytoolbox.in/electrical-safety/

**Web Resources:**

1. slideshare.net/slideshow/electrical-safety-and-risk-assessments/45837604

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | UTILIZATION OF ELECTRICAL ENERGY (PE-I) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

**1. To impart knowledge on the selection and application of electric drives** for various mechanical and industrial processes, emphasizing efficiency and control.

**2. To provide a comprehensive understanding of electrical heating and welding methods**, their operating principles, and industrial applications.

**3. To enable students to analyze and design effective illumination systems**, considering factors like luminous efficiency, lighting schemes, and economic operation.

**4. To develop an understanding of electric traction systems**, including braking methods, traction motors, and traction mechanics relevant to transportation.

5. **To explain the principles and industrial uses of electrolytic processes**, including electroplating, electrorefining, and electrolysis.

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

| | |
|---|---|
| **CO 1** | Apply the appropriate electric drives for various industrial applications. -L4 |
| **CO 2** | Understand the different types of heating and welding techniques. -L2 |
| **CO 3** | Design an illumination system for the proper lighting system. -L5 |
| **CO 4** | Understand the basic principle and different braking techniques of electric traction. -L2 |
| **CO 5** | Understand the basic principle and applications of the electrolytic process.-L1 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 3 | | 2 | | | | 1 | 1 | 2 | 1 | 2 | 3 | 2 |
| CO2 | 3 | 2 | | | 2 | | 2 | | | | | 1 | 2 | 3 | 2 |
| CO3 | 3 | | 3 | 2 | 2 | 2 | 2 | | | 2 | 1 | 1 | 2 | 3 | 2 |
| CO4 | 3 | 1 | 2 | 2 | 2 | 1 | | | | | 1 | 1 | 2 | 3 | 2 |
| CO5 | 3 | | | | 2 | 1 | 2 | | | | | 1 | 2 | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Electric Drives

Type of electric drives – rating and choice of motor - starting and running characteristics – particular applications of electric drives - types of industrial loads - Continuous - intermittent and variable loads.

### MODULE -2: Electric Heating & Welding

**Introduction:** Advantages and methods of electric heating - resistance heating - induction heating and dielectric heating.

**Electric welding:** Classification- resistance and arc welding - electric welding equipment - comparison between AC and DC Welding.

### MODULE-3: Illumination

Introduction - terms used in illumination - laws of illumination - sources of light. Discharge lamps – mercury vapor and sodium vapor lamps–comparison between tungsten filament lamps and fluorescent tubes–compact fluorescent lamp–LED-Basic principles of light control-Types and design of good lighting system and practice - flood lighting.

| MODULE-4: Electric Traction | |
|---|---|
| Traction systems: System of electric traction and track electrification - Review of existing electric traction systems in India - Special features of traction motor - Speed-time curves for different services - methods of electric braking - plugging - rheostatic braking - regenerative braking. Introduction to Magnetic Levitation vehicles. | |
| **MODULE-5: Electrolytic Process** | |
| Introduction - Basic principles - Faradays laws of electrolysis - Energy efficiency – Electrodeposition - Factors governing deposition Processes - Deposition of Alloys – Extraction and refining of metals. Fuel Cells. | |
| **Total hours:** | 54 |

**Term work:**
Field trip to electric locomotive limited ,Tirupati and submit report on energy consumption for different electric locomotives

**Content beyond syllabus:**
Energy Efficient Technologies in Electrical Systems

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Electric Drives And Traction | CO1 | https://www.electronicshub.org/electric-traction-system/ |
| 2 | Mechanics Of Electric Traction | CO2 | https://www.engineeringenotes.com/electrical- engineering/electric-traction-electrical-engineering/train-movement-and-energy-consumption-electrical-engineering/37136 |
| 3 | Illumination | CO3 | https://nptel.ac.in/courses/108/105/108105060/ |
| 4 | Heating And Welding | CO4 | https://www.electrical4u.com/electric-heating/ **twi-global.com/technical-knowledge/faqs/what-is-arc- welding** |
| 5 | Solar & Wind Energy Conversion System | CO5 | https://www.sciencedirect.com/topics/engineering/solar-collector https://www.awea.org/wind-101/basics-of-wind-energy https://www.slideshare.net/BansiKansagara/et-wind |

**Text Book(s):**
1. C.L Wadhwa, Generation Distribution and Utilization of Electrical Energy, New age International Publishers,
2. J. B. Gupta, Utilization of Electrical Power and Electric Traction, S. K. Kataria and sons, 2002
3. G. C. Garg (2005), Utilization of Electrical Power & Electric traction, 8th edition, Khanna publishers, New Delhi.
4. N. V. Suryanarayana, Utilization of Electrical Power including Electric drives and Electric traction, New Age International (P) Limited, Publishers, 1996.

**Reference Book(s):**
1. Partab (2007), Art & Science of Utilization of electrical Energy, 2nd edition, Dhanpat Rai & Sons, New Delhi.
2. Alan. V. Oppenheim, Ronald. W. Schafer, John R Buck, Discrete Time Signal Processing,

| |
|---|
| PrenticeHall,2ndedition,2006.E.OpenshawTaylor,UtilizationofElectricEnergy,Orient Longman,1971. |
| **Online Resources:**<br>1. https://nptel.ac.in/courses/108105060<br>2. https://nptel.ac.in/courses/112105221 |
| **Web Resources:**<br>1. https://vssut.ac.in/lecture_notes/lecture1426861925.pdf<br>2. https://vpmpee.wordpress.com/uee-3340903/ |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | MACHINE MODELING AND ANALYSIS (PE-1) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total | Credit | Max Marks | | |
| | L | T | P | **hrs** | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:** Fundamental concepts of Electrical Machines and Electro Magnetic Fields.

**Course Objectives:**

Able to understand the

1. Able to analyze the Basic Concepts of Modeling Electrical machines.
2. To understand Mathematical model of the DC Motor.
3. Able to analyze the dynamic modeling and phase transformation.
4. To understand the Modeling of Induction Machine.
5. To understand the Dynamic Analysis of Synchronous Machine.

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

| | |
|---|---|
| **CO 1** | Understand the basic concepts of AC/ DC machine modeling. (BL-2) |
| **CO 2** | Understand the Mathematical model of the DC Machine. (BL-2) |
| **CO 3** | Analyze the Reference frame theory model of Electrical machine.(BL-3) |
| **CO 4** | Analyze the steady state and dynamic state operation of three-phase induction machine.(BL-3) |
| **CO 5** | Analyze the modeling and simulation of three phase synchronous machine .(BL-3) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 2 | 2 | 2 | | 2 | | | | | | | 1 | 3 |
| **CO2** | 2 | 2 | 2 | | | | | | | | | | 2 | 3 |
| **CO3** | 2 | 2 | 2 | | | 2 | | | | | | | 2 | 3 |
| **CO4** | 3 | 2 | | | | | | | | | | | 2 | 3 |
| **CO5** | 2 | 3 | | | | 2 | | | | | | | 1 | 3 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1 BASIC CONCEPTS OF MODELING

Basic Two - pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine - voltage, current and Torque equations.

### MODULE -2 MODELING OF DC MACHINES

Mathematical model of separately excited D.C motor –Steady State analysis - Transient State analysis - Sudden application of Inertia Load - Transfer function of Separately excited D.C Motor - Mathematical model of D.C Series motor, Shunt motor - Linearization Techniques for small perturbations.

### MODULE-3 REFERENCE FRAME THEORY

Reference frame theory Real time model of a two phase induction machine - three phase to two phase transformation - Dynamic modeling of three phase Induction Machine - Stator reference frame model - Rotor reference frame model Synchronously rotating reference frame model.

### MODULE-4 MODELING OF INDUCTIONMACHINES

Three phase induction machine, equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary Reference frame variables – analysis of dynamic performance for load torque variations.

| MODULE-5 | MODELING AND ANALYSIS OFSYNCHRONOUS MACHINES |
|---|---|

Synchronous machine inductances – voltage equations in the rotor's dq0 reference frame - electromagnetic torque - current in terms of flux linkages - simulation of three phase synchronous machine.

Dynamic performance of synchronous machine, three -phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria.

| | |
|---|---|
| **Total hours:** | **54** |

**Term work:**

1. Compare and Contrast the Mathematical model of different types of DC Motors submit the report.
2. Compare and Contrast the 3 phase synchronous machine with and without damper bars and submit the report.
3. Analyze the two phase induction machine and three phase induction machine and submit the report.
4. Analyze the Synchronous motor and PM Synchronous motor and submit the report.

**Content beyond syllabus:**

1. Symmetrical Two phase Induction Machine.
2. Unsymmetrical Two phase Induction Machine.
3. Modeling of PM Synchronous motor.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Module | Reference |
|---|---|---|
| 1 | BASIC CONCEPTS OF MODELING | https://nptel.ac.in/courses/112/107/112107220/ |
| 2 | MODELING OF DC MACHINES | https://nptel.ac.in/courses/108/106/108106023/ |
| 3 | REFERENCE FRAME THEORY | http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php |
| 4 | MODELING OF INDUCTION MACHINES | https://nptel.ac.in/courses/108/106/108106023/ |
| 5 | MODELING AND ANALYSIS OF SYNCHRONOUS MACHINES | https://nptel.ac.in/courses/108/101/108101004/ |
| 6 | DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINES | https://nptel.ac.in/courses/108/106/108106023/ |

**Text Book(s):**

1. R. Krishnan, "Electric Motor Drives - Modeling, Analysis & Control", PHI Learning Private Ltd, 2009.
2. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.
2. Sawhney, A.K., "A Course in Electrical Machine Design", Dhanpat Rai & Sons, New Delhi, 2013.

**Reference Book(s):**

1. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 5th Edition, 2014.
2. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, "Electric Machinery", Tata McGraw Hill, 5th Edition, 1992.
3. Chee Mun Ong –"Dynamic simulation of Electric machinery using MATLAB / Simulink", Prentice Hall of India Publications.
4. Ramamoorthy M, "Computer Aided Design of Electrical Equipment", East-West Press.

**Online Resources/ Web References:**

1. https://books.google.co.in/books?id=0_D6gfUHjcEC&printsec=frontcover#v=onepage&q&f=false
2. http://nptel.ac.in/courses/108106023/
3. https://easyengineering.net/electrical-machinery-by-bimbhra/
4. https://www.hindawi.com/journals/mpe/2017/7348263/
5. https://nptel.ac.in/courses/108/106/108106023/
6. https://nptel.ac.in/courses/108/102/108102146/
7. http://www.ijrimsec.com/assoc_art/volume7_1/Ch_10.pdf
8. https://nptel.ac.in/courses/108/106/108106023/#

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **ADVANCED POWER SEMICONDUCTOR DEVICES AND PROTECTION (PE-I)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total **hrs** | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:** Review of introductory concepts of power semiconductor devices

**Course Objectives:**

**OBJECTIVES:**

1. To improve power semiconductor device structures for adjustable speed motor control applications.
2. To understand the static and dynamic characteristics of current controlled power semiconductordevices
3. To understand the static and dynamic characteristics of voltage controlled power semiconductordevices
4. To enable the students for the selection of devices for different power electronics Applications
5. To understand the control and firing circuit for different devices.

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

| | |
|---|---|
| **CO 1** | Analyze power switching devices **(BL-4)** |
| **CO 2** | Design of current controlled devices and their parameters**(BL-3)** |
| **CO 3** | Analyze the voltage controlled devices and their parameters **(BL-2)** |
| **CO 4** | Understand new power semiconductor devices**(BL-2)** |
| **CO 5** | Design of protecting circuit**(BL-3)** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 2 | | | | | | | | | | | 2 | 2 |
| **CO2** | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| **CO3** | 3 | 2 | | | | | | | | | | | 2 | 2 |
| **CO4** | 3 | 2 | | | | | | | | | | | 2 | 2 |
| **CO5** | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| 1: Low, 2-Medium, 3- High | | | | | | | | | | | | | | |

| **COURSE CONTENT** | |
|---|---|
| **MODULE – 1** | **POWER SWITCHING DEVICES** |
| Power switching devices overview – Attributes of an ideal switch, application requirements,circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state andswitching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating. | |

| MODULE -2 | CURRENT CONTROLLED DEVICES |
|---|---|
| BJT's – Construction, static characteristics, switching characteristics; Negative temperaturecoefficient and second breakdown; - Thyristors – Physical and electrical principle underlyingoperating mode, Two transistor analogy – concept of latching; Gate and switchingcharacteristics; converter grade and inverter grade and other types; series and paralleloperation; comparison of BJT and Thyristor – steady state and dynamic models of BJT Thyristors- Basics of GTO, MCT, FCT, RCT | |
| **MODULE-3** | **VOLTAGE CONTROLLED DEVICES** |
| Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types,static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs -and IGCT | |
| **MODULE-4** | **NEW SEMICONDUCTOR MATERIALS FOR DEVICES** |
| New semiconductor materials for devices – Intelligent power modules- Integratedgate commutated thyristor (IGCT) - Comparison of all power devices. | |
| **MODULE-5** | **FIRING AND PROTECTING CIRCUITS** |
| Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET,IGBTs and base driving for power BJT. - Over voltage, over current and gate protections;Design of snubbers.Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling | |
| **Total hours:** | **54** |

**Term work:**

1. Study of design of SiC MOSFETs
2. Tabulate the details of SCRs of different ratings
3. Derivation and explanation of transient thermal impedance of SCR
4. Study of thermal design of SCR with derivations
5. Study and explain paper on the state of the art and future trends of power semiconductors

**Content beyond syllabus:**

Protection against external & internal over voltages.

**Self-Study:**

Contents to promote self-Learning:

| S.NO | Module | Reference |
|---|---|---|
| 1 | Power Switching Devices | https://www.youtube.com/watch?v=7XsuRUXF4wE |
| 2 | Current Controlled Devices | https://www.youtube.com/watch?v=5Jf_WWt-5vg |
| 3 | Voltage Controlled Devices | https://www.youtube.com/watch?v=lzwqcMvuYxU |
| 4 | New Semiconductor Materials For Devices | https://www.youtube.com/watch?v=88lo7MgCpNo |
| 5 | Firing And Protecting Circuits | https://www.youtube.com/watch?v=XyuY8OgMQL4 |

**Text Book(s):**

1. B.W Williams 'Power Electronics Circuit Devices and Applications'..
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004
3. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
4. Mohan, Undeland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.
5. Joseph Vithayathil, Power Electronics: Principles and Applications, Delhi, Tata McGraw-Hill, 2010.

**Reference Book(s):**

1. Advanced power electronics converters by Euzeli dos santos, Edison R. da silva.
2. Fundamentals of Power Semiconductor Devices by B. JayanthBaliga, Springer Press, 2008.
3. Power Semiconductor Devices and Circuits, Jaecklin, **A.A.**
4. Fundamentals of Power Semiconductor Devices, **Baliga**, B. Jayant

**Online Resources/ Web References:**

1. https://www.amazon.in/Power-Electronics-Drives-Advanced-Applications-ebook/dp/B086H4Z9WY
2. https://www.pdfdrive.com/25-advanced-power-semiconductor-devices-apsd-e456994.html
3. https://www.ttiinc.com/content/ttiinc/en/resources/product-types/discretes.html?utm=1267&channel=ppc&gclid=CjwKCAjw1K75BRAEEiwAd41h1AEeMfdQ65z0DUsEWQSBV_cFEI5VwuQnFLxopFizjnXDYRY4iPtUoRoCkAEQAvD_BwE
4. http://site.iugaza.edu.ps/malramlawi/files/RASHID_Power_Electronics_Handbook.pdf
5. https://www.youtube.com/watch?v=h0Y9jDKqScQ&list=PLgMDNELGJ1CaNcuuQv9xN07ZWkXE-wCGP
6. https://www.youtube.com/watch?v=m-uY4fja_Jw&list=PLOzRYVm0a65dVYOA7_3-N67Xu1NIrLnR0
7. https://www.youtube.com/watch?v=-YgHdIqkbs0
8. https://www.youtube.com/watch?v=5-uQ4rLlWPE

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **AI & ML for ELECTRICAL ENGINEERING (PE-II)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. **To introduce the fundamental concepts and architecture of Artificial Intelligence (AI)** relevant to electrical engineering applications.
2. **To impart knowledge on Artificial Neural Networks (ANN)** including their structure, learning mechanisms, and algorithmic implementation.
3. **To enable students to apply ANN techniques to solve real-world problems** in electrical engineering, such as fault detection, load forecasting, and control systems.
4. **To familiarize students with the principles of Fuzzy Logic**, fuzzy sets, membership functions, and inference systems.
5. **To equip students with the ability to design and implement Fuzzy Logic-based systems** in electrical engineering contexts such as motor control, power quality analysis, and energy management.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding the Basics and Architecture of Artificial Intelligence -L1 |
| **CO 2** | Analyzing and Applying Artificial Neural Networks (ANN) Concepts -L3 |
| **CO 3** | Implementing ANN Applications in Real-World Problems -L5 |
| **CO 4** | Understanding and Applying Fuzzy Logic Concepts -L2 |
| **CO 5** | Designing and Implementing Fuzzy Logic Applications -L5 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 2 | | | 2 | | | | | 1 | | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | 1 | 1 | 1 | 2 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | 1 | | 2 | 2 | 1 | 3 | 2 | 3 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 3 | | 2 | | 1 | 1 | | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | | 2 | 2 | 1 | 3 | 2 | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction to Artificial Intelligence

Introduction and motivation - Approaches to AI - Architectures of AI - Symbolic Reasoning System - Rule based Systems - Knowledge Representation - Expert Systems.

### MODULE -2: Overview of Machine Learning

The Motivation & Applications of Machine Learning: Learning Associations, Classification, Regression; Supervised Learning; Unsupervised Learning; Reinforcement Learning; Gradient Descent: Batch Gradient Descent, Stochastic Gradient Descent; Data pre processing; Under fitting and Over fitting issues.

### MODULE-3: Artificial Neural Networks

Basics of ANN - Comparison between Artificial and Biological Neural Networks - Basic Building Blocks of ANN - Artificial Neural Network Terminologies - McCulloch Pitts Neuron Model - Learning Rules - ADALINE and MADALINE Models - Perceptron Networks (Continuous and Discrete) – Perceptron Convergence Theorem - Back Propagation Neural Networks - Associative Memories – BAM and Hopfield networks.

### MODULE-4: Fuzzy Logic

| |
|---|
| Classical Sets - Fuzzy Sets - Fuzzy Properties, Operations and relations - Fuzzy Logic System - Fuzzification - Defuzzification - Membership Functions - Fuzzy Rule base - Fuzzy Logic Controller Design. |
| **MODULE-5: Applications of AI Techniques** |
| Load forecasting, Load flow studies, Economic load dispatch, Speed control of DC Motor, Speed Control of Induction Motors. |
| **Total hours:** 54 |

**Term work:**
MATLAB simulation with any example

**Content beyond syllabus:**
MATLAB tool box for projects

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | AI Rule based Systems | CO1 | https://www.geeksforgeeks.org/artificial-intelligence/rule-based-system-in-ai/ |
| 2 | Reinforcement Learning | CO2 | https://www.geeksforgeeks.org/machine-learning/what-is-reinforcement-learning/ |
| 3 | ADALINE and MADALINE Models | CO3 | geeksforgeeks.org/machine-learning/adaline-and-madaline-network/ |
| 4 | Fuzzy Logic System | CO4 | https://www.geeksforgeeks.org/artificial-intelligence/fuzzy-logic-introduction/ |
| 5 | AI based Economic load dispatch | CO5 | https://www.ijareeie.com/upload/2013/july/58_%20Economic.pdf |

**Text Book(s):**

1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Neural Networks using MATLAB", McGraw Hill Edition, 2006.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Third Edition, WILEY India Edition, 2012.
3. Ethem Alpaydin, ―Introduction to Machine Learning‖, MIT Press, 3rd edition, 2014
4. Russell. S and Norvig. P, ―Artificial Intelligence - A Modern Approach‖, 4 th edition, Pearson, 2022

**Reference Book(s):**

1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Fuzzy Logic using MATLAB", Springer International Edition, 2013.
2. Yung C. Shin and Chengying Xu, "Intelligent System - Modeling, Optimization & Control, CRC Press, 2009.
3. Kevin P. Murphy, ―Machine Learning: A Probabilistic Perspective‖, MIT Press, 2012

**Online Resources:**
https://www.youtube.com/watch?v=NCqUYw6oNR4

**Web Resources:**
https://iimtu.edu.in/blog/the-future-of-electrical-engineering-with-ai-ml/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **Electrical Machine Design (PE-II)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Basic Electrical Engineering, DC Machines, Induction machines, Transformers and Synchronous machines**

**Course Objectives:**

1. To discuss the properties of electrical, magnetic and insulating materials used in the design of electrical machines.
2. To design armature and field systems for D.C. machines.
3. To design core, yoke, windings and cooling systems of transformers.
4. To design stator and rotor of induction machines.
5. To design stator and rotor of synchronous machines and study their thermal behavior.

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

| | |
|---|---|
| **CO 1** | Understand the basic principles of machine design. (BL-2) |
| **CO 2** | Analyze the performance design DC motor. (BL-4) |
| **CO 3** | Analyze the performance design winding and core of transformer. (BL-4) |
| **CO 4** | Analyze the performance design winding and core of rotating electrical machine. (BL-4) |
| **CO 5** | Analyze the short circuit ratio and its effects on performance of synchronous machines. (BL-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | | | | | | | | | | | | | |
| CO2 | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | |
| CO3 | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | |
| CO4 | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | |
| CO5 | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | PRINCIPLES OF ELECTRICAL MACHINE DESIGN |
|---|---|

Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines.

| MODULE -2 | DESIGN OF DC MACHINES |
|---|---|

Output equation, choice of specific loadings and choice of number of poles, design of Main dimensions of the DC machines, Design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and poles- main and inter poles, field windings – shunt, series and inter poles.

| MODULE-3 | DESIGN OF TRANSFORMERS |
|---|---|
| Output Equations for single phase and three phase transformers, expression for volts/turn, Main Dimensions, Window space factor, Design of core and winding, Overall dimensions , expression for leakage reactance and voltage regulation, No load current , Temperature rise in Transformers ,Design of Tank, Methods of cooling of Transformers. | |
| **MODULE-4** | **Design of Induction Motors** |
| Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance of single phase and Three Phase Induction motor. | |
| **MODULE-5** | **Design of Three Phase Synchronous Machines** |
| Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors. Magnetic Circuit and Field Winding. | |
| **Total hours:** | **54** |

**Term work:**

1. Field trip visit at Voltactive Power Technologies Pvt Ltd Vijayawada to understand the design of transformer .
2. Develop armature winding diagram for DC and AC machines Develop a layout for substation using the standard symbols for substation equipment through Auto CADD
3. Draw sectional views of core and shell types transformers using the design data through Auto CADD
4. Draw sectional views of assembled DC machine or its parts using the design data or the sketches through Auto CADD.

**Content beyond syllabus:**

1. Design of small transformer
2. Modelling Of Electro Static and Magnetic Device.
3. Estimation of material and electrical installation of motor in different industry

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | Reference |
|---|---|---|
| 1 | Principles Of Electrical Machine Design | http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php |
| 2 | Design of DC Machines | https://nptel.ac.in/courses/108/106/108106023/ |
| 3 | Design of Transformers | http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php |
| 4 | Design of Induction Motors | https://nptel.ac.in/courses/108/106/108106023/ https://nptel.ac.in/courses/108/106/108106023/ |
| 5 | Design of Three Phase Synchronous Machines | https://nptel.ac.in/courses/108/106/108106023/ |

**Text Book(s):**


1. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, 2011.
2. M.V.Deshpande "Design and Testing of Electrical Machine Design" Wheeler Publications, 2010.
3. V.N. Mittle and A. Mittle, "Design of Electrical Machines", 5th Edition, Standard Publications and Distributors, 2014, New Delhi.

**Reference Book(s):**


1. A.Shanmuga Sundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 2007.
2. R.K.Agarwal " Principles of Electrical Machine Design" Esskay Publications, 5th Edition Delhi, 2014.
3. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987
4. Ramamoorthy M, "Computer Aided Design of Electrical Equipment", East-West Press.
5. M. N. O. Sadiku, " Numerical techniques in Electromagnetics", CRC Press Edition-2001.
6. M.V. Deshpande, "Design and Testing of Electrical Machines"PHI learning, New Delhi.


**Online Resources:**

https://nptel.ac.in/courses/108/106/108106023/

**Web Resources:**

http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php


JuhaPyrhonen, TapaniJokinen, Valeria Hrabovcova "Design of Rotating Electrical Machines", ISBN: 978-0-470-69516-6. Willey Publication Hardcover. 538 pages. February 2009. .

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **PROGRAMMABLE LOGIC CONTROLLERS (PE-II)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. The student will be able to:
2. Understand the basic functions and types of PLCs, Easy Veep software, its applications
3. Understand Classification of PLCs and applications
4. Design PLC Programming for various applications
5. Analyze PLC Troubleshooting aspects

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understand different types of PLCs, Its classification and the usage of Easy Veep software-L2 |
| **CO 2** | Analyze the hardware details of Allen Bradley PLC -L3 |
| **CO 3** | Design PLC Programming for various applications – L5 |
| **CO 4** | Apply PLC programming concepts in different fields of Science and Technology -L4 |
| **CO 5** | Develop Instruction using ADD and SUB functions, UP and Down counters – L5 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 2 | | | 2 | | | | | 1 | | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | | 2 | 3 | | | | | 1 | | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 3 | 2 | 3 | | | | 1 | 1 | 1 | 3 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 1 | | | 1 | 2 | 1 | 3 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | 3 | | | | | 1 | | 2 | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction to PLCs

Basic functions of PLCs, Mechanical relays versus PLC, Different types of PLC‘s – Allen-Bradley – Micrologix: ML1000, ML1100, SLC500, Compact Logix, Mitsubishi FX series, HMI‘s, Processor and I/O cards

### MODULE -2: PLC Computational Tool

Introduction to Easy Veep software, Link between mechanical, electrical and programming documentation, Logic diagrams, Flip-Flop Logic, M8000, M8001 internal bits interpretation, Binary code, data table, manipulation and search engine in Mitsubishi environment Communication between PC and PLC, Communication between PC and HMI, PLC and HMI Serial Local network, Introduction to SLC500

### MODULE-3: PLC Development

PLC software and applications, Boolean algebra – understanding binary code, ADD and SUB functions, UP and Down Counters, Introduction to k1Y0, MOV function, CPR and ZCP functions, SHWT and SHRD instructions, Introduction to Absolutely Drum Instruction. Allen Bradley PLC: Introduction to Rockwell Software, Hardware focus, Hardware considerations (Field wiring, Master Control Relay, VFD), Basic programming and applications, Cascade control – subroutine, Different programs.

### MODULE-4: PLC Programming

| |
|---|
| Programming instructions: Instructions and binary interpretation, Bit Instruction, Timers and counters, Comparison instructions, Programming Instructions - Math instructions, Move and Logical Instructions, Discussions of programming, communications for PLC-Robotic arm, Exercise of setup and monitoring. |
| **MODULE-5: Applications** |
| Analog and Digital parameters by using SLC5/03-VFD-Panel Mate series 1700, Practical Troubleshooting, troubleshooting technique, Control system stability and tuning basics. Applications: Process to rewind, test, and integrate with extrusion process for wiring and fibre optic industries, Food industry – yeast, flour distribution and control. Process Medical equipment Industry – Gas analyzer, Leak tester (using CO2), plastic wrapping machines etc. |

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**
Industrial field work based report submission

**Content beyond syllabus:**
Human Machine Interfacing techniques in industry

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Mitsubishi FX series | CO1 | https://www.youtube.com/watch?v=a9gioBs3F1I |
| 2 | M8000, M8001 internal bits interpretation | CO2 | https://plc.home.blog/2018/09/26/how-to-understand-m8000-m8001-m8002-in-mitsubishi-plc/ |
| 3 | Introduction to Absolutely Drum Instruction | CO3 | https://cdn.automationdirect.com/static/manuals/d1user_11_18/ch6.pdf |
| 4 | Instructions and binary interpretation | CO4 | https://control.com/technical-articles/plc-programming-commands-boolean-functions-and-bit-redistribution/ |
| 5 | Control system stability and tuning basics | CO5 | https://www.geeksforgeeks.org/control-systems-stability/ |

**Text Book(s):**
1. Automating manufacturing systems with PLCs by Hugh Jack, 2010.
2. PLC Hand Book (Automationdirect Siemens)

**Reference Book(s):**
1. Programmable Logic Controllers by R. Bliesener, F Ebel, Festo. Didactic publishers, 2002.
2. Programmable Logic Controllers by W. Bolton, 4th Edition, Newnes, 2006.
3. Introduction to PLCs by Jay F. Hooper, 2nd Edition, Carolina Academic Press, 2006.

**Online Resources:**
https://nptel.ac.in/courses/108105088

**Web Resources:**
https://repository.dinus.ac.id/docs/ajar/PLC_Beginner_guide.pdf

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | SWITCHGEAR AND PROTECTION (PE-II) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** To make the students learn about:

1. The study of different Circuit Breakers and Relays.
2. The protection of Generators and Transformers.
3. To discuss the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
4. The protection of various feeder bus bars from abnormal conditions and over voltages & importance on neutral grounding for overall protection.

**Course Outcomes**: After completing the course, the student should be able to do the following:

| | |
|---|---|
| **CO 1** | Understand the operation of different circuit breakers and their specifications. -L2 |
| **CO 2** | Analyze the concepts of different relays which are used in real time power system operation. -L3 |
| **CO 3** | Apply various protective schemes for Transformers, Rotating machines. L4 |
| **CO 4** | Explain different protective schemes used for Bus bars and Feeders. L3 |
| **CO 5** | Understand the methods of protection against over voltages and importance of neutral grounding. L2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 2 | | | | | | | | | | | 3 | 2 | 2 |
| **CO2** | 3 | 2 | | | | | | | | | | | 3 | 2 | 2 |
| **CO3** | 3 | 2 | | | | | | | | | | | 3 | 2 | 2 |
| **CO4** | 3 | 2 | | | | | | | | | | | 3 | 2 | 2 |
| **CO5** | 3 | 2 | | | | | | | | | | | 3 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Circuit Breakers

Circuit Breakers: Elementary principles of arc interruption, Recovery, Restriking Voltage and Recovery voltages - Restriking Phenomenon, Average, Max. RRRV, Current Chopping and Resistance Switching - CB ratings and Specifications, Selection of CB: Types and Numerical Problems. – Auto reclosures. Description and Operation of- Minimum Oil Circuit breakers, Air Blast Circuit Breakers, Vacuum and SF6 circuit breakers.

### MODULE -2: Electromagnetic, Static and Numerical Relays

Basic Requirements of Relays – Primary and Backup protection - Construction details of – Attracted armature, balanced beam, inductor type and differential relays – Universal Torque equation – Characteristics of over current, Direction and distance relays. Static Relays – Advantages and Disadvantages – Definite time, Inverse and IDMT static relays – Comparators – Amplitude and Phase comparators. Microprocessor based relays – Advantages and Disadvantages – Block diagram for over current (Definite, Inverse and IDMT), Distance Relays, Impedance Relays and Reactance Relays with their Flow Charts.

### MODULE-3: Protection of Generators and Transformers

Protection of generators: Protection of generators against Stator faults, Rotor faults, and Abnormal Conditions. Restricted Earth fault and Inter-turn fault Protection. Numerical Problems on percentage winding unprotected. Protection of transformers: Percentage Differential Protection, Numerical Problem on Design of CTs Ratio, Buchholtz relay Protection.

| MODULE-4: Protection of Feeders, Transmission Lines and Busbars | |
|---|---|
| Protection of Feeders (Radial & Ring main) using over current Relays. Protection of Transmission lines – 3 Zone protection using Distance Relays. Carrier current protection. Protection of Bus bars - Differential protection, Differential Pilot wire protection. | |
| **MODULE-5: Protection Against Over Voltages** | |
| Generation of Over Voltages in Power Systems. -Protection against Lightning Over Voltages - Valve type and Zinc-Oxide Lighting Arresters - Insulation Coordination –BIL. Neutral Grounding, Grounded and Ungrounded Neutral Systems. - Effects of Ungrounded Neutral on system performance. Methods of Neutral Grounding: Solid, Resistance, Reactance – Arcing Grounds and Grounding Practices. | |
| **Total hours:** | 54 |

**Term work:**
Field work to EHV Substation / Tutorials/ Quiz's

**Content beyond syllabus:**

1. Carrier current protection
2. Insulation Coordination, Basic Impulse Insulation Level

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Circuit Breakers | CO1 | https://www.electrical4u.com/electrical-circuit-breaker-operation-and-types-of-circuit-breaker/ |
| 2 | Protective relays | CO2 | https://circuitglobe.com/types-of-circuit-breaker.html |
| 3 | Electromagnetic Relays | CO3 | https://www.electrical4u.com/electromagnetic-relay- working-types-of-electromagnetic-relays/ |
| 4 | Generator protection | CO4 | https://circuitglobe.com/differential-protection-relay.html https://circuitglobe.com/impedance-type-distance- relay.html https://www.engineeringenotes.com/electrical-engineering/comparators/amplitude-comparators-and-its-types-devices-electrical-engineering/32806 |
| 5 | Neutral grounding | CO5 | https://circuitglobe.com/differential-protection-of-a-generator.html https://circuitglobe.com/differential-protection-of-a-transformer.html https://circuitglobe.com/feeder-protection.html#:~:text=Feeder%20Protection,the%20vari ous%20type%20of%20fault. |

**Text Book(s):**

1. Switchgear and Protection – by Sunil S Rao, Khanna Publishers.
2. Power System Protection and Switchgear by Badari Ram, D.N Viswakarma, TMH Publications.

**Reference Book(s):**

1. Protective Relaying Principles and Applications – J Lewis Blackburn, CRC Press.
2. Numerical Protective Relays, Final Report 2004 – 1009704 EPRI, USA.
3. Protective Relaying Theory and Applications - Walter A Elmore, Marcel Dekker.
4. Transmission network Protection by Y.G. Paithankar, Taylor and Francis, 2009.
5. Power System Protection- P. M. Anderson, Wiley Publishers.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc22_ee101/preview
2. http://175.101.102.82/moodle/course/view.php?id=691
3. https://subjects.ee.unsw.edu.au/elec9712/ELEC9712%20-%20Lec8%20-%20Circuit%20breakers%20Notes.pdf
4. https://b-ok.asia/book/5482781/8e4867
5. https://b-ok.asia/book/5482780/4ec690

**Web Resources:**

1. https://nptel.ac.in/courses/108/101/108101039/
2. https://www.youtube.com/watch?v=GSh0f94JwaA&t=54s
3. https://www.youtube.com/watch?v=dPInm2zoirA&t=40s
4. https://www.youtube.com/watch?v=OH7-NJRdDyA
5. https://www.youtube.com/watch?v=Kd_73FnTueI
6. https://www.youtube.com/watch?v=OElOqRSN0FE
7. https://www.youtube.com/watch?v=Y5dAaeLPzzk
8. https://www.youtube.com/watch?v=ODj4sWxKm9o

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | SOLAR AND FUEL CELL ENERGY SYSTEMS (PE-II) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To make students understand the fundamental theory governing the photovoltaic devise and make them carry out preliminary system design.
2. To learn the fundamental knowledge about various fuel cell technologies.

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

| | |
|---|---|
| **CO 1** | Understand the need of radiation of sun and discuss the various performance characteristics of solar radiation.(BL-2) |
| **CO 2** | Discuss the photovoltaic effect, PV Cell efficiency and its limits along with the concepts of fabrication technology for solar cell (BL-2) |
| **CO 3** | Predict the performance of solar photovoltaic device and analyze its performance. (BL-2) |
| **CO 4** | Carry out the application of photovoltaic system as power system. (BL-3) |
| **CO 5** | Analyze the performance of fuel cells under different operating conditions and also defend appropriate fuel cell technology for a given application. (BL-4) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 2 | 1 | | | 2 | 2 | | | | | | 2 | 1 |
| CO2 | 3 | 3 | 3 | | | 2 | 2 | | | | 2 | | 3 | 2 |
| CO3 | 2 | 2 | 1 | | | 2 | 2 | | | | 2 | | 2 | 2 |
| CO4 | 2 | 2 | | | | 2 | 2 | 2 | | | 2 | | 3 | 3 |
| CO5 | 2 | 3 | 2 | | | 2 | 2 | | | | 2 | | 2 | 1 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1 Solar Radiation

Sun as Energy Source, Solar Radiation at The Earth's Surface, Solar Radiation Geometry, Solar Time and Equation of Time, Sun Earth angles, Sun path diagram, Sunshine hours, Measurement of Solar Diffuse, Global and Direct Solar Radiation, Equipments, Estimation of Solar radiation on horizontal and tilted Surfaces, Global Solar radiation data, Indian Solar Radiation data analysis

### MODULE -2 Solar Cells and its Fabrication

**Solar Cells**

Conversion of Solar energy into Electricity - Photovoltaic Effect, Equivalent Circuit of the Solar Cell, Analysis of PV Cells: Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, High efficiency cells, Recent developments in Solar Cells, Role of nano-technology in Solar cells

**Fabrication Technology for Solar Cells**

High efficiency multi-junction solar cell, Quantum well solar cell, Technology for the fabrication of thin film cells, Optical concentration, Effect of temperature on Cell performance, Thermo photovoltaic effect

### MODULE-3 Solar Photovoltaic System

**Solar Photovoltaic System Design**
Solar cell array system analysis and performance prediction, Shadow analysis: Reliability, Solar cell array design concepts, PV system design, Design process and optimization: Detailed array design, Voltage regulation, Maximum tracking, Quick sizing method, Array protection.
**Solar Photo Voltaic System Testing**
Sun Simulator, Testing and performance assessment of Solar PV generator, Electronic Control and Regulation, Power Conditioning, Converters and inverter, Concentrating system, System design and configuration

| **MODULE-4** | **SPV Power Systems** |
|---|---|

Centralized and decentralized SPV systems, Stand alone, hybrid and, grid connected system, System installation, Operation and Maintenance, Application of PV for lighting, Water pumping. Refrigeration, Telecommunication, Cathodic Protection, Solar PV Power Plant-Status-Case Studies, Hybridization Engineering, Hybrid systems, Grid integration. Building Integrated PV Systems, PV market analysis and Economics of SPV systems.

| **MODULE-5** | **FUEL CELLS** |
|---|---|

History, Working principle of fuel cells, Fuel cell thermodynamics, fuel cell electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Volmer equation, performance evaluation of fuel cells, Types of Fuel Cells: AFC, PAFC, SOFC, MCFC, DMFC, relative merits and demerits.
**Fuel cell characterization** In-situ and ex-situ characterization techniques, I-V curve, frequency response analyses; Fuel cell system integration
**Application of Fuel Cells** Fuel Cell usage for domestic power systems, large scale power generation, Automobile, environmental analysis. Future trends in fuel cells, portable fuel cells, laptops, mobiles, submarines.

| **Total hours:** | **54** |
|---|---|

**Term work:**
1. Field trip

**Content beyond syllabus:**
1. Introduction of hydrogen energy systems
2. Hydrogen production processes
3. Hydrogen storage and safety

**Self Study:**

| SNO | MODULE | Reference |
|---|---|---|
| 1 | Indian Solar Radiation data analysis | https://www.nrel.gov/docs/fy21osti/78025.pdf |
| 2 | Role of nano-technology in Solar cells | https://www.intechopen.com/chapters/73145 |
| 3 | Converters and inverter in solar energy | https://www.energy.gov/eere/solar/solar-integration-inverters-and-grid-services-basics |
| 4 | Economics of SPV systems | https://extensionpublications.unl.edu/assets/pdf/g2182.pdf |
| 5 | Types of Fuel cells with relative merits and demerits | https://www.energy.gov/eere/fuelcells/types-fuel-cells |

**Text Book(s):**

1. Fundamentals of Solar Cells: PV Solar Energy Conversion by AL Fahrenbruch and RH Bube, Academic Press, New York.
2. Solar Photovoltaics. Fundamental Technologies and Application by Chetan Singh Solanki, PHI Publicaton.
3. Principles of Fuel Cells by Xianguo Li, Taylor & Francis.
4. Fuel cell Systems Explained by James Larminie and Andrew Dicks, John Wiley & Sons, Inc.
5. Fuel Cells: From Fundamentals to Applications by S Srinivasan, Springer.

**Reference Book(s):**

1. Principles of Solar Engineering by F Kreith and JF Kreider, McGraw-Hill.
2. Fuel Cell Fundamentals by O'Hayre, SW Cha, W Colella and FB Prinz, Wiley.
3. Fuel Cell Science and Technology by Basu, S. (Ed) Springer, N.Y.

**Online Resources:**

1. https://www.nrel.gov/docs/fy21osti/78025.pdf
2. https://www.intechopen.com/chapters/73145
3. https://www.energy.gov/eere/solar/solar-integration-inverters-and-grid-services-basics
4. https://extensionpublications.unl.edu/assets/pdf/g2182.pdf
5. https://www.energy.gov/eere/fuelcells/types-fuel-cells

**Web References:**

1. https://www.youtube.com/watch?v=--GfdbavEk8
2. https://www.youtube.com/watch?v=qFnAIxyPXuQ
3. https://www.youtube.com/watch?v=px239v5o6xU
4. https://www.youtube.com/watch?v=pH03Y5KwpjU
5. https://www.youtube.com/watch?v=6oeN9VDFLig

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | ELECTRIC DRIVES (PE-III) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. **To provide comprehensive knowledge about the fundamentals and classifications of electric drives**, including their steady-state and dynamic operating characteristics.
2. **To develop analytical skills in evaluating the performance of DC drives** controlled by various types of rectifiers under different modes of operation.
3. **To enable students to analyze chopper-fed DC motor drives** and understand their applications in modern electric drive systems.
4. **To impart knowledge of inverter-fed induction motor drives**, including scalar and vector control strategies under various load and speed conditions.
5. **To familiarize students with the operational principles and control of synchronous motor drives and stepper motor drives**, especially in automation and industrial applications.

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

| | |
|---|---|
| **CO 1** | Evaluate the characteristics and operational aspects of drives operating in different modes.-L3 |
| **CO 2** | Analyze the operational aspects of various controlled rectifiers fed DC drives operating in different sustainable modes of operation.-L3 |
| **CO 3** | Analyze the operational aspects of various controlled chopper fed DC drives operating in different sustainable modes of operation.-L3 |
| **CO 4** | Analyze the operational aspects of various asynchronous motor drives operating in different sustainable modes of operation. -L3 |
| **CO 5** | Analyze the operational aspects of synchronous motor and stepper motor drives operating in different sustainable modes of operation. -L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 2 | 2 | 2 | | | | | 1 | | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | | | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | | | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | | | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction To Electric Drives

Electrical drives — block diagram, advantages of electric drive, parts of electric drives, choice of electrical drives, the status of DC and AC drives. Dynamics of electrical drives-fundamental torque equations, speed-torque conventions, and multi-quadrant operation; Equivalent values of drive parameters - loads with rotational and translational motion; Load torques — components, nature and classification. Concept of steady-state stability. Electric braking methods — regenerative, dynamic and plugging. Modes of operation of electrical drives — steady state, acceleration including starting and deceleration including stopping. Speed control and drive classifications, closed-loop control of drives — current limit control, torque control, speed control and position control (Block diagram only).

### MODULE -2: Single-Phase and Three Phase Converter Fed DC Drives

Control of DC separately excited motor by single-phase and three-phase half and full bridged converters — voltage and current waveforms for continuous and discontinuous conduction, speed-torque expressions and characteristics. Single phase half-controlled rectifier fed DC series motor — voltage and current waveforms for continuous and discontinuous conduction, speed-torque expressions and characteristics. Multi-quadrant operation of DC separately excited DC motor fed from fully controlled rectifier - mechanical reversible switch in armature, dual converter and field current reversal.

**MODULE-3: DC Chopper Fed Drives**

Control of DC separately excited motor by one ,two and four quadrant choppers - voltage and current waveforms for continuous conduction (motoring, regenerative and dynamic braking), speed-torque expressions and characteristics. Chopper control of DC series motor—operation, speed-torque expressions and characteristics. Closed loop chopper control of separately excited DC motor (Block diagram only).

**MODULE-4: Induction Motor Drives**

Three phase induction motors — Introduction, Stator variable voltage control — speed-torque characteristics, AC voltage controllers and efficiency of induction motor under voltage control. Stator variable voltage and variable frequency control — slip speed control, torque-power limitations and modes of operation. Voltage Source Inverters (VSIs) and Current Source Inverters (CSIs) fed induction motor and closed loop operation of induction motor drives (Block diagram only).Comparison of VSI and CSI fed drives. Static rotor resistance control, slip power recovery schemes – static scherbius and kramer drive, speed-torque characteristics.

**MODULE-5: Synchronous and Stepper Motor Drives**

Synchronous Motor Drives: Separate control and self-control of synchronous motors — operations of self-controlled synchronous motors by VSI and CSI. Load commutated CSI fed Synchronous motor—operation and speed torque characteristics. Closed loop control operation of synchronous motor drives (Block diagram only). Stepper Motor Drives: Variable reluctance and permanent magnet operation — features of stepper motor — torques Vs stepping rate characteristics and drive circuits. BLDC motor operation and control.

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**
MATLAB Simulation based report submission

**Content beyond syllabus:**
Cycloconverter fed synchronous motor drives

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Thyristor Controlled Drives | CO1 | https://www.youtube.com/watch?v=-EC6q5_grM4 |
| 2 | Four Quadrant Operation | CO2 | https://www.youtube.com/watch?v=Tfrv9DJfVgs |
| 3 | Chopper Fed DC Motors | CO3 | https://www.youtube.com/watch?v=pdjVSWSQ83w |
| 4 | AC Voltage Controller fed AC drives | CO4 | https://www.youtube.com/watch?v=Pc7txXwvhBM |
| 5 | Slip Power Recovery scheme | CO5 | https://www.youtube.com/watch?v=9Z0Tn5iTYyE |

**Text Book(s):**
1. Gopal K. Dubey, Fundamentals of Electric Drives, Narosa Publications, Alpha Science International Ltd, 2nd Edition, 2002.

2. M. H. Rashid (2003), Power Electronic Circuits, Devices and applications, 3rd edition, Prentice Hall of India, New Delhi, India.
3. Krishnan, Ramu. Electric motor drives: modeling, analysis, and control, 1st Edition, Pearson, 2015.

**Reference Book(s):**

1. M. D. Singh, K. B. Khanchandani (2008), Power Electronics, 2nd Edition, Tata McGraw Hill Publications, New Delhi.
2. VedamSubramanyam (2008), Thyristor Control of Electric drives, 1st Edition, Tata McGraw Hill Publications, New Delhi, India.
3. S. K. Pillai (2007), A First course on Electrical Drives, 2nd Edition, New Age International (P) Ltd.,NewDelhi
4. P.C. Sen, Principles of Electrical Machines and Power Electronics, Wiley, 3rdEdition, 2013.

**Online Resources:**

1. https://web.iitd.ac.in/~amitjain/Drives_VTR.pdf
2. https://sde.uoc.ac.in/sites/default/files/sde_videos/Electrical%20Drives%20and%20Controls_0.pdf
3. https://nptel.ac.in/courses/108/104/108104140/

**Web Resources:**

1. https://nptel.ac.in/courses/108/102/108102046/
2. https://swayam.gov.in/nd1_noc19_ee65/preview

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | COMMUNICATION SYSTEMS (PE-III) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To understand the fundamentals of communication systems and amplitude modulation techniques.
2. To learn about the angle modulation techniques and bandwidth considerations in communication systems.
3. To gain knowledge on pulse analog modulation and multiple access techniques used in digital communication systems.
4. To examine pulse modulation and digital modulation techniques used in modern communication systems.
5. To study wireless communication systems, cellular networks, and GSM technology.

**Course Outcomes**: At the end of this course, the students will be able to

| | |
|---|---|
| **CO 1** | Understand the fundamentals of communication systems and amplitude modulation techniques. L1 |
| **CO 2** | Learn about the angle modulation techniques and bandwidth considerations in communication systems. L2 |
| **CO 3** | Gain knowledge on pulse analog modulation and multiple access techniques used in digital communication systems. L3 |
| **CO 4** | Get familiar with pulse modulation and digital modulation techniques used in modern communication systems.L3 |
| **CO 5** | Know about wireless communication systems, cellular networks, and GSM technology.L2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO1** | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO2** | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 |
| **CO5** | 3 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: Analog communication-I**

Elements of communication systems, need for Modulation, Modulation Methods, Baseband and carrier communication Amplitude Modulation (AM), Generation of AM signals, Rectifier detector, Envelope detector, sideband and carrier power of AM, Double side band suppressed carrier (DSB-SC) modulation & its demodulation, Switching modulators, Ring modulator, Balanced modulator, Single sideband (SSB) transmission, VSB Modulation.

**MODULE -2: Analog communication-II**

Angle Modulation & Demodulation: Concept of instantaneous frequency Generalized concept of angle modulation, Bandwidth of angle modulated waves- Narrow band frequency modulation (NBFM); and Wide band FM (WBFM), Phase modulation, Pre-emphasis & De-emphasis, Illustrative Problems.

**MODULE-3: Digital communications-I (Qualitative Approach only)**

Pulse analog modulation techniques, Generation and detection of Pulse amplitude modulation, Pulse width modulation, Pulse position modulation

**Multiple Access Techniques:** Introduction to multiple access techniques, FDMA, TDMA, CDMA, SDMA: Advantages and applications

| MODULE-4: Digital communications-II (Qualitative Approach only) | |
|---|---|
| Pulse Code Modulation, DPCM, Delta modulation, Adaptive delta modulation, Overview of ASK, PSK, QPSK, BPSK and M-PSK techniques. | |
| **MODULE-5: Wireless communications (Qualitative Approach only)** | |
| Introduction to wireless communication systems, Examples of wireless communication systems, comparison of 2G and 3G cellular networks, Introduction to wireless networks, Differences between wireless and fixed telephone networks, Introduction to Global system for mobile (GSM), GSM services and features. | |
| **Total hours:** | 54 |

**Term work:**
Report submission on FDMA, TDMA, CDMA, SDMA and GSM services

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Double side band suppressed carrier (DSB-SC) modulation | CO1 | https://www.tutorialspoint.com/analog_communication/analog_communication_dsbsc_modulation.htm |
| 2 | Bandwidth of angle modulated waves | CO2 | https://www.tutorialspoint.com/principles_of_communication/principles_of_communication_angle_modulation.htm |
| 3 | Generation and detection of Pulse amplitude modulation | CO3 | https://www.geeksforgeeks.org/electronics-engineering/pulse-amplitude-modulation/ |
| 4 | Adaptive delta modulation | CO4 | https://www.elprocus.com/adaptive-delta-modulation-block-diagram-and-applications/ |
| 5 | Wireless communication systems | CO5 | https://www.geeksforgeeks.org/computer-networks/wireless-communication-set-1/ |

**Text Book(s):**
1. H Taub, D. Schilling and Gautam Sahe, ―Principles of Communication Systems‖, TMH, 2007, 3rd Edition.
2. George Kennedy and Bernard Davis, ―Electronics & Communication System‖, 4th Edition, TMH 2009.
3. Wayne Tomasi, ―Electronic Communication System: Fundamentals Through Advanced‖, 2nd edition, PHI,2001.

**Reference Book(s):**
1. Simon Haykin, ―Principles of Communication Systems‖, John Wiley, 2nd Edition.
2. Sham Shanmugam, ―Digital and Analog communication Systems‖, Wiley-India edition,2006.
3. Theodore. S.Rapport, ―Wireless Communications‖, Pearson Education, 2nd Edition,2002.

**Online Resources:**
https://www.sciencedirect.com/topics/engineering/communication-system
https://testbook.com/physics/electronic-communication-systems

**Web Resources:**
https://en.wikipedia.org/wiki/Communications_system

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **RENEWABLE AND DISTRIBUTED ENERGY TECHNOLOGIES (PE-III)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To This course explores each of the principal renewable energy sources in turn. Each technology is examined in terms of the relevant physical principles; the main technologies involved; environmental impact; the size of the potential renewable resource; and the future prospects of green energy.
2. This Distributed Generation course is intended to provide knowledge of the benefits of renewable energy generation, availability of distributed generation technology, electricity generation technologies, issues related to grid interconnection, and methods of analyzing the technical and economic feasibility.

**Course Outcomes**: At the end of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Comprehend the renewable energy scenario, anticipate future energy demand and to understand the abstraction concept of electrical energy from Solar Energy. -L3 |
| **CO 2** | Understand the abstraction concept of electrical energy from wind, bio-mass and Tidal energy sources. -L2 |
| **CO 3** | Understand electrical energy storage along with working of Green Energy.-L2 |
| **CO 4** | Exemplify rudimentary idea of Distributed Generation.-L3 |
| **CO 5** | Comprehend the technical impact, control, and economic aspects of Distributed Generation. -L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | 1 | | | | | | | | | | 1 | | 2 |
| **CO2** | 2 | 2 | | | | | | | | | | | 1 | 2 | 2 |
| **CO3** | 2 | 1 | | | | | | | | | | | 1 | 1 | 2 |
| **CO4** | 2 | 1 | 1 | | | | | | | | | | | 2 | 2 |
| **CO5** | 1 | 1 | 1 | | | | | | | | | | 1 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Energy Scenario and Solar Energy

**Introduction:** Fundamentals of renewable energy sources, Types of energy, Renewable and Non-renewable energy, SWOT analysis, Global warming and climate change, World energy transformation by 2050, Prospects of renewable energy in the world, Renewable energy availability in India.

**Solar Energy Fundamentals:** Solar Spectrum, propagation of solar radiation from the sun to earth; solar radiation geometry: sun-earth geometry, extra-terrestrial and terrestrial radiation.

**Solar Thermal:** Solar Collectors, Solar parabolic trough, Solar tower, Solar cooker, Solar water heater, Solar dryer, Solar Pond.

**Solar Electric Power Generation:** A Generic PV Cell, PV Materials, Equivalent Circuits for PV Cells, Modules and Arrays; I-V Curve under Standard Testing Conditions; Impact of Temperature and Insolation on I-V curves; Shading Impacts on I-V curves; Maximum Power Point Trackers (MPPT).

### MODULE -2: Wind and Other Energy Systems

**Wind Energy:** Air, Wind, Global and Local Wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Classification of wind energy conversion system (WECS)- Horizontal axis- single, double and multiblade system. Vertical axis- Savonius and darrieus types.

**Biomass Energy:** Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies-fixed dome; Urban waste to energy conversion; Biomass gasification (Downdraft).
**Tidal Power:** fundamental characteristics of tidal power, harnessing tidal energy, advantages, and limitations.

**MODULE-3: Energy Storage and Green Energy**

**Energy Storage:** Stationary Battery Storage – Basics of Lead-Acid batteries, Battery Storage Capacity, Coulomb efficiency instead of energy efficiency, Battery Sizing. Different Battery storage technologies and comparison of their performance. Introduction to Super capacitors.
**Green Energy:** Historical Development, Basic Operation of a Fuel Cell, Fuel Cell Thermodynamics, Entropy and the theoretical efficiency of Fuel Cells, Gibbs Free Energy and Fuel Cell efficiency, Electrical output of an Ideal Cell, Electrical Characteristics of Real Fuel Cells, Types of Fuel Cells, H2: Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.

**MODULE-4: Introduction to DG and its Grid Integration**

**Introduction:** Need for Distributed generation, renewable sources in distributed generation, current scenario in Distributed Generation, Planning of DGs – Siting and sizing of DGs – optimal placement of DG sources in distribution systems.
**Grid integration of DGs:** Different types of interfaces - Inverter based DGs and rotating machine-based interfaces - Aggregation of multiple DG units. Energy storage elements: Batteries, ultracapacitors, flywheels.

**MODULE-5: Technical Impact, Economic and Control aspects of DG**

**Technical impacts of DGs:** Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems
**Economic and control aspects of DGs:** Market facts, issues, and challenges - Limitations of DGs. Voltage control techniques, Reactive power control, Harmonics, Power quality issues. Reliability of DG based systems – Steady-state and Dynamic analysis.

**Total hours:** 54

**Term work:**
Individual assignment, followed by Quiz and End semester examinations

**Content beyond syllabus:**
Advance energy conversion process

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Electric Energy ConversionSystems | CO1 | https://www.britannica.com/technology/energy-conversion |
| 2 | solar energy conversion systems | CO2 | https://www.appropedia.org/Solar_energy_conversion_sy https://www.sciencedirect.com/topics/engineering/thermasolar-energy-system-technology |
| 3 | Thermal andBio-energy conversion systems | CO3 | http://www.fao.org/3/T1804E/t1804e06.html |
| 4 | Wind Energy Conversion Systems | CO4 | https://www.appropedia.org/Wind_energy_conversion_sy |
| 5 | Fuel cell technology | CO5 | https://www.hydrogenics.com/technology-resources/hydrogen-technology/fuel-cells/ |

**Text Book(s):**

1. Muhammad Kamran, Muhammad Rayyan Fazal, "Renewable Energy Conversion Systems", First Edition, Elsevier Academic Press, 2021.
2. G. D. Rai, Non-Conventional Sources of Energy, Khanna Publisher, 2004

**Reference Book(s):**

1. G N Tiwari, Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa, 2002.
2. Mukund R Patel, Wind and Solar Power Systems: Design, Analysis, and Operation, 2nd Edition, Taylor & Francis, 2006.
3. H. Lee Willis, Walter G. Scott, ―Distributed Power Generation – Planning and Evaluation‖, Marcel Decker Press, 2000.
4. Gilbert M. Masters, ―Renewable and Efficient Electric Power Systems‖, 2nd Edn., IEEE Press, Wiley, 2013.
5. N. Jenkins, J.B. Ekanayake and G. Strbac, ―Distributed Generation‖, 1st Edn, The Institution of Engineering and Technology, London, 2010.

**Online Resources:**

1. https://archive.nptel.ac.in/courses/121/106/121106014/#
2. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
3. https://www.nptelvideos.com/lecture.php?id=8517

**Web Resources:**

1. https://www.youtube.com/watch?v=mpHZWYpKDJg
2. https://www.youtube.com/watch?v=GExTwRNkQBg

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **Programmable Control Devices and Applications (PE-III)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite**: To Learn about Power Electronic devices, Semiconductor drives, Energy storage systems( Battery, Fuel Cell, Super Capacitor etc).

**Course Objectives:**

1. Understand the basic functions and types of PLCs.
2. Get exposure of Easy Veep software, its applications.
3. Classification of PLCs and applications
4. Programming using PLCs .
5. Troubleshooting aspects using PLCs.

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

| | |
|---|---|
| **CO 1** | Understand different types of PLCs (BL-2) |
| **CO 2** | Understand the usage of Easy Veep software (BL-1) |
| **CO 3** | Understand the hardware details of Allen Bradley PLC . (BL-2) |
| **CO 4** | Programming of PLCs . (BL-2) |
| **CO 5** | Know about few applications of PLCs in different fields of Science and Technology . (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | | | | | | 2 | | | | | | 2 | 3 |
| CO2 | 2 | | | | | | | | | | | | 2 | 2 |
| CO3 | 3 | | 1 | | | | | | | | | | 1 | 2 |
| CO4 | 2 | | | | | | | | | | | | 1 | |
| CO5 | 2 | | | | | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | INTRODUCTION |
|---|---|

Basic functions of PLCs, Mechanical relays versus PLC, Different types of PLC's – AllenBradley – Micrologix: ML1000, ML1100, SLC500, Compact Logix, Mitsubishi FX series, HMI's, Processor and I/O cards.

| MODULE -2 | Logic diagrams |
|---|---|

Introduction to Easy Veep software, Link between mechanical, electrical and programming documentation, Logic diagrams, Flip-Flop Logic, M8000, M8001 internal bits interpretation, Binary code, data table, manipulation.

| MODULE-3 | PLC software and applications |
|---|---|

PLC software and applications, Boolean algebra – understanding binary code, ADD and SUB functions, UP and Down Counters, Introduction to k1Y0, MOV function, CPR and ZCP functions, SHWT and SHRD instructions, Introduction to Absolutely Drum Instruction.

| MODULE-4 | PLC Hardware |
|---|---|

Allen Bradley PLC: Introduction to Rockwell Software, Hardware focus, Hardware considerations (Field wiring, Master Control Relay, VFD), Basic programming and applications, Cascade control – subroutine, Different programs.

| MODULE-5 | PLC IC applications |
|---|---|

| | |
|---|---|
| Programming instructions: Instructions and binary interpretation, Bit Instruction, Timers and counters, Comparison instructions, Programming Instructions - Math instructions, Move and Logical Instructions, Discussions of programming, communications for PLC-Robotic arm, Exercise of setup and monitoring. | |
| **Total hours:** | **54** |

**Term work:**

Term work contains minimum two group assignments followed by seminars and quiz's

**Content beyond syllabus:**

1. Hybridization of different energy storage devices
2. Mechanics of Electric Vehicles

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Introduction to PLC | CO1 | https://www.youtube.com/watch?v=PbAGl_mv5XI |
| 2 | PLC logic circuits | CO2 | https://www.youtube.com/watch?v=X3xGqdb0DAA |
| 3 | PLC software applications | CO3 | https://www.youtube.com/results?search_query=PLC+software+ |
| 4 | PLC Hardware applications | CO4 | https://www.youtube.com/results?search_query=plc+hardware+components |
| 5 | PLC IC applications | CO5 | https://www.youtube.com/watch?v=JvTCgq5vss0 |

**Text Book(s):**

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
3. Electric Vehicle Technology Explained-James Larminie, John Lowry-John Wiley & Sons Ltd,-2003
4. Electric & Hybrid Vehicles-Design Fundamentals-Iqbal Hussain, Second Edition, CRCPress,2011

**Reference Book(s):**

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. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.
3. Iqbal Husain, "Electric and Hybrid Electric Vehicles", CRC Press, 2011.
4. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, WILEY, 2017

**Online Resources / Web References:**

1. https://b-ok.asia/book/1226776/eceb4b
2. https://b-ok.asia/book/3357286/21e776
3. http://ceb.ac.in/knowledge-center/E-BOOKS/Modern%20Electric,%20Hybrid%20Electric%20&%20Fuel%20Cell%20Vehicles%20-%20Mehrdad%20Ehsani.pdf
4. https://b-ok.asia/book/3516646/6fe038
5. https://nptel.ac.in/courses/108/103/108103009/
6. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl
7. https://www.youtube.com/watch?v=11e_d3Q9jEc

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | WIND & BIOMASS ENERGY SYSTEM (PE-III) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To acquire the knowledge on wind power generation
2. To Understand the concept of wind turbine design
3. To Discuss the Current trends in worldwide applications of wind power
4. To Understand the various methods Bio- Chemical Conversion systems
5. To Discuss the various applications of biomass

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

| | |
|---|---|
| **CO 1** | Understand the present wind energy scenario (BL-2) |
| **CO 2** | Explain the various wind energy technologies. (BL-3) |
| **CO 3** | Identify various applications of wind energy .(BL-2) |
| **CO 4** | Explain the various biomass conversion technologies and testing of performance of biogas. (BL-2) |
| **CO 5** | Understand the Bio-Energy Systems with Efficient Applications. (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | 3 | 2 | 2 | | | | | | | | | 2 | 1 |
| CO2 | 3 | 1 | 1 | 2 | | | | | | | | | 3 | 2 |
| CO3 | 3 | 3 | 2 | 1 | | | | | | | | | 2 | 2 |
| CO4 | 2 | 2 | 3 | 2 | | | | | | | | | 3 | 3 |
| CO5 | 1 | 2 | 1 | | 2 | | | | | | | | 2 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | Wind Power Generation |
|---|---|

Introduction – Basic principles of wind energy conversion power in the wind-Forces on blades and thrust on turbines – Wind energy conversion – site selection Considerations -Basic components of WECS – Classification- Advantages and disadvantages – Power, torque and speed characteristics.

| MODULE -2 | WECS design |
|---|---|

Design of wind turbine :Wind turbine design considerations; Methodology; Theoretical simulation of wind turbine characteristics; Test methods.

Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss Correction.

| MODULE-3 | Wind Energy Applications & Measurements |
|---|---|

Wind energy measurements: Wind speed, Wind direction, Data measurement and analysis, Performance evaluation of Wind energy system, Wind potential assessment

Wind energy application Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy. Utilization; Wind energy in India; Case studies.

| MODULE-4 | Biomass conversion Technologies |
|---|---|

**Bio Energy:** Introduction – Biomass conversion technologies – Bio gas generation – Factors affecting bio digestion or generation of gas – Classification of bio gas plants – advantages and disadvantages –Materials used for biogas plant – selection of site for biogas plant
**Thermo-chemical conversions:** Direct Combustion, Technology of Biomass gasification, Pyrolysis and Liquefaction, Bio- Chemical Conversion: anaerobic digestion, alcohol production from biomass,
**Chemical conversion process:** hydrolysis and hydrogenation
**Biomass Gasifiers:** History, Principle, Design of Biomass Gasifiers, updraft gasifier, down draft gasifier, zero carbon biomass gasification plants, Gasification of plastic-rich waste, applications for cooking, electricity generation, Gasifier Engines, Operation of spark ignition and compression ignition engine with wood gas, methanol, ethanol and biogas, Biomass integrated gasification/combined cycles systems.

| **MODULE-5** | **Bio-Energy Systems with Efficient Applications** |
|---|---|

Traditional Stoves, Energy Efficient Cooking and Space heating Stoves, Metal Stoves Improved Gasifier Stoves, Pollution due to smoke emissions, Biogas Systems : Technology of Bio-gas production, Biogas Plants , Digester types, Digester design, Chemical kinetics and mathematical modeling of bio-methanation process, Dung, Vegetable Waste, Night Soil and Municipal Waste based Bio-gas plants, Bio gas as fuel for transportation, Lighting, Running Dual Fuel Engines, Electricity generation, Bio gas Bottling Plant Technology, Application of Bio gas slurry in agriculture , Design of Biogas for cold climates.

| | |
|---|---|
| **Total hours:** | **54** |

**Term work:**

1. Field trip

**Content beyond syllabus:**

1. Betz limit & Wind resource assessment

**Self-Study:**

Contents to promote self-Learning:

| SNO | MODULE | Reference |
|---|---|---|
| 1 | Basic components of WECS | https://www.youtube.com/watch?v=uUzqfckAlbg |
| 2 | Prandlt's tip loss Correction | https://www.youtube.com/watch?v=F9J2BdprXOQ |
| 3 | Wind energy measurements | https://www.youtube.com/watch?v=-N-QJkY1GEM |
| 4 | Biomass conversion technologies<br>Design of Biomass Gasifiers | https://www.youtube.com/watch?v=H1hrkC--dto<br>https://www.youtube.com/watch?v=RrBOqjCtkk0 |
| 5 | Night Soil and Municipal Waste based Bio-gas plants | https://www.youtube.com/watch?v=ehNEtJtaFR8 |

**Text Book(s):**

1. S.N.Bhadra,D.Kastha, S.Banerjee, " wind electrical systems" Oxford University Press
2. S.Rao & B.B.Parulekar, "Energy Technology", 4th edition, Khanna publishers, 2005.
3. "Energy conversion systems" by Rakosh das Begamudre, New age international publishers, New Delhi - 2000.

**Reference Book(s):**

1. "Renewable Energy sources & Conversion Technology" by N.K.Bansal, Manfred Kleemann, Michael Meliss. Tata Mcgraw Hill Publishers.
2. "The Electrical Energy Storage" by IEC Market Strategy Board.
3. Jim Eyer, Garth Corey, "Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report", Press, Feb 2010.

**Online Resources:**

1. https://www.lathamathavan.edu.in/lmgi/antiragging/WECS-%21EEE%20new.pdf
2. https://www.lathamathavan.edu.in/lmgi/antiragging/WECS-%21EEE%20new.pdf
3. https://engineering.purdue.edu/~dionysis/EE452/Lab9/Wind_Energy_Conversion.pdf
4. https://energystorage.org/why-energy-storage/technologies/
5. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118029008

**Web References:**

1. https://www.youtube.com/watch?v=mh51mAUexK4
2. https://www.youtube.com/watch?v=GExTwRNkQBg
3. https://www.youtube.com/watch?v=4a4XGu1mR5E
4. https://www.youtube.com/watch?v=xzY3CK43C98
5. https://www.youtube.com/watch?v=_OQtT4yhhWc

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | ELECTRIC VEHICLE TECHNOLOGY (PE - IV) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. **To introduce the fundamental concepts of electric vehicles**, their types, components, and comparison with conventional vehicles.
2. **To impart knowledge on electric drivetrain topologies** and their relevance to vehicle performance, control, and energy efficiency.
3. **To classify and analyze various types of electric propulsion systems** and drives used in electric vehicles.
4. **To provide insights into energy storage systems**, particularly batteries and supercapacitors, along with their characteristics and selection criteria.
5. **To familiarize students with different energy management strategies** for optimizing vehicle performance, range, and sustainability.

**Course Outcomes**: At the end of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Illustrate electric vehicles. (L2) |
| **CO 2** | Understand drive-train topologies. (L2) |
| **CO 3** | Classify various electrical drives (L2) |
| **CO 4** | Classify energy storage technologies. (L2) |
| **CO 5** | Classify different energy management strategies. (L2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 2 | | | 2 | 1 | 2 | | | 1 | | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | | 2 | | | | | 1 | | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 3 | | | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 2 | | 2 | 3 | | 2 | | | 1 | | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 2 | 3 | | 1 | 1 | 1 | 3 | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction To Electric Vehicles

History of electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies.

**CASE STUDY:** Comparison by efficiency of Conventional, Hybrid, Electric and Fuel cell Vehicles.

### MODULE -2: Electric Drive-Trains

Basic concept of electric traction, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies.

### MODULE-3: Electric Drives & Control

Introduction to electric components used in electric vehicles, Control of BLDC Motor, Control of Induction Motor Drive, Permanent Magnet (PM) motor Drive & Switched Reluctance Motor (SRM) Drive.

### MODULE-4: Energy Storage

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its modeling, SOC, Different Types of Batteries, Super Capacitor based energy storage and its analysis, Fuel Cells, Hybridization of different energy storage devices.

| MODULE-5: Energy Management Strategies & Charging Infrastructure | |
|---|---|
| Introduction to energy management strategies used in electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, Types of EV charging Infrastructure & Standardized Communication protocols for EV charging.<br>**CASE STUDY:** Current issues in electric Vehicles, Thermal Protection of Battery. | |
| **Total hours:** | 54 |

**Term work:**

Term work contains minimum two group assignments followed by seminars and quiz's

**Content beyond syllabus:**

1. Hybridization of different energy storage devices
2. Mechanics of Electric Vehicles

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Introduction to Electric Vehicles | CO1 | https://nptel.ac.in/content/storage2/courses/108103009/download/M1.pdf https://www.youtube.com/watch?v=KOLBGKMo3zQ |
| 2 | Hybrid Electric Drive-trains | CO2 | https://www.youtube.com/watch?v=oydKVcJqPQ0 https://nptel.ac.in/content/storage2/courses/108103009/ download/M3.pdf |
| 3 | DC & AC Motor drives | CO3 | https://www.youtube.com/watch?v=1AT1yuQ9awM&list= PLFW6lRTa1g83slfVY1p1xGqPGYUmXyahx |
| 4 | Energy Storage Systems & Energy Management Strategies | CO4 | https://www.youtube.com/watch?v=j7RaL_XKywk https://nptel.ac.in/content/storage2/courses/108103009/ download/M10.pdf |
| 5 | Hybrid Vehicle Control Strategy | CO5 | https://nptel.ac.in/content/storage2/courses/108103009/ download/M12.pdf |

**Text Book(s):**

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, —Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2 nd Edition, 2017. (Unit-I, II)
2. Ali Emadi, —Advanced Electric Drive Vehicles (Energy, Power Electronics, and Machines)‖, CRC Press, 2015. (Unit-III)
3. John G. Hayes and A. Goodarzi, —Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles‖, Wiley, 2018. (Unit-IV & V)

**Reference Book(s):**

1. James Larminie, John Lowry, —Electric Vehicle Technology Explained‖, Wiley, 2 nd Edition 2012.

**Online Resources:**

1. https://b-ok.asia/book/1226776/eceb4b
2. https://b-ok.asia/book/3357286/21e776
3. http://ceb.ac.in/knowledge-center/E-BOOKS/Modern%20Electric,%20Hybrid%20Electric%20&%20Fuel%20Cell%20Vehicles%20-%20Mehrdad%20Ehsani.pdf
4. https://b-ok.asia/book/3516646/6fe038
5. https://nptel.ac.in/courses/108/103/108103009/

6. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl
https://www.youtube.com/watch?v=11e_d3Q9jEc

**Web Resources:**

1. https://nptel.ac.in/courses/108106170
2. https://onlinecourses.nptel.ac.in/noc22_ee53
3. https://onlinecourses.nptel.ac.in/noc21_ee112

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | DIGITAL SIGNAL PROCESSING (PE - IV) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To get familiar with the properties of discrete time signals, systems and z-transform.
2. To learn the importance of FFT algorithm for computation of Discrete Fourier Transform and Fast Fourier Transform with decimations.
3. To understand the implementations of digital filter structures.
4. To analyse the FIR filter design using Fourier series and windowing methods.
5. To gain the knowledge on Programmable DSP Devices.

**Course Outcomes**: At the end of the course, the students will be able to

| | |
|---|---|
| **CO 1** | Familiar with the properties of discrete time signals, systems and z-transform. L2 |
| **CO 2** | Learn the importance of FFT algorithm for computation of Discrete Fourier Transform and Fast Fourier Transform with decimations. L3 |
| **CO 3** | Understand the implementations of digital filter structures. L1 |
| **CO 4** | Analyse the FIR filter design using Fourier series and windowing methods. L3 |
| **CO 5** | Gain the knowledge on Programmable DSP Devices. L2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | | 1 | 2 | | | | | | | | 2 | 2 |
| CO2 | 3 | 2 | 1 | 2 | 3 | | | | | | | | 2 | 2 |
| CO3 | 3 | 2 | 2 | 2 | 3 | | | | | | | | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 3 | | | | | | | | 2 | 2 |
| CO5 | 2 | 1 | | 1 | 3 | | | | | | | 1 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction to discrete time signals and systems & Z-Transform

**Introduction to discrete time signals and systems:** Introduction to digital signal processing, Review of discrete-time signals and systems, Analysis of discrete-time linear time invariant systems, frequency domain representation of discrete time signals and systems.

**Z–Transform:** Definition, ROC, Properties, Poles and Zeros in Z-plane, the inverse Z-Transform, System analysis, Transfer function, BIBO stability, System Response to standard signals, Solution of difference equations with initial conditions, Illustrative Problems, analysis of linear time-invariant systems in the z-domain, pole-zero stability.

### MODULE -2: Discrete Fourier Transform & Fast Fourier Transform

**Discrete Fourier Transform:** Introduction, Discrete Fourier Series, properties of DFS, Discrete Fourier Transform, Inverse DFT, properties of DFT, Linear and Circular convolution, convolution using DFT.

**Fast Fourier Transform:** Introduction, Fast Fourier Transform, Radix-2 Decimation in time and Decimation in frequency FFT, Inverse FFT (Radix-2).

### MODULE-3: IIR Filters

Introduction to digital filters, Analog filter approximations – Butterworth and Chebyshev, Design of IIR Digital filters from analog filters by Impulse invariant and bilinear transformation methods, Frequency transformations, Basic structures of IIR Filters - Direct form-I, Direct form-II, Cascade form and Parallel form realizations.

### MODULE-4: FIR Filters

| |
|---|
| Introduction, Characteristics of FIR filters with linear phase, Frequency response of linear phase FIR filters, Design of FIR filters using Fourier series and windowing methods (Rectangular, Triangular, Raised Cosine, Hanging, Hamming, Blackman), Comparison of IIR & FIR filters, Basic structures of FIR Filters – Direct form, Cascade form, Linear phase realizations. |
| **MODULE-5: Architectures for Programmable DSP Devices** |
| Architecture of TMS320C5X: Introduction, Bus Structure, Central Arithmetic Logic Unit, Auxiliary Register ALU, Index Register, Block Move Address Register, Parallel Logic Unit, Memory mapped registers, program controller, some flags in the status registers, On- chip memory, On-chip peripherals. |

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**
Applications on various filters with suitable analysis

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | BIBO stability | CO1 | https://www.tutorialspoint.com/signals-and-systems-bibo-stability-criterion |
| 2 | Linear and Circular convolution | CO2 | https://thewolfsound.com/circular-vs-linear-convolution-whats-the-difference/#google_vignette |
| 3 | Digital filters from analog filters by Impulse invariant transformation methods | CO3 | https://www.sciencedirect.com/topics/engineering/impulse-invariant-method |
| 4 | Comparison of IIR & FIR filters | CO4 | https://www.geeksforgeeks.org/electronics-engineering/difference-between-fir-filter-and-iir-filter/ |
| 5 | On-chip peripherals | CO5 | https://www.slideshare.net/slideshow/unit-ii-study-of-onchip-peripherals/46154533 |

**Text Book(s):**

1. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, Pearson Education, 2007.
2. A.V.Oppenheim and R.W. Schaffer, Discrete Time Signal Processing ,PHI

**Reference Book(s):**

1. S.K.Mitra, Digital Signal Processing – A practical approach , 2nd Edition, Pearson Education, New Delhi, 2004.
2. MH Hayes, Digital Signal Processing, Schaum‘s Outline series, TATA Mc-Graw Hill, 2007.
3. Robert J. Schilling, Sandra L. Harris, Fundamentals of Digital Signal Processing using Matlab, Thomson, 2007.

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc22_ee99/preview,
2. https://nptel.ac.in/courses/108105055

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | HVDC AND FACTS (PE-IV) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** To get the student exposed to

1. High voltage DC transmission systems
2. Flexible AC transmission systems
3. Various configurations of the above, Principle of operation, Characteristics of various FACTS devices

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Remember various conventional control mechanisms, transmission networks. -L1 |
| **CO 2** | Understand the necessity of HVDC systems as emerging transmission networks. -L2 |
| **CO 3** | Understand the necessity of reactive power compensation devices. -L2 |
| **CO 4** | Design equivalent circuits of various HVDC system configurations. -L5 |
| **CO 5** | Design and analysis of various FACTS devices. -L5 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 2 | | | 2 | | | | | 1 | | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 1 | 1 | | | 1 | | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 1 | 2 | | | 1 | | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | | | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 1 | 2 | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction

Electrical Transmission Networks, Conventional Control Mechanisms-Automatic Generation Control, Excitation Control, Transformer Tap-Changer Control, Phase-Shifting Transformers; Advances in Power-Electronic Switching Devices, Principles and Applications of Semiconductor Switches; Limitations of Conventional Transmission Systems, Emerging Transmission Networks, HVDC and FACTS. Concepts of virtual inertia

### MODULE -2: High Voltage Dc Transmission – I

Types of HVDC links - Monopolar, Homopolar, Bipolar and Back-to-Back, Advantages and disadvantages of HVDC Transmission, Analysis of Graetz circuit, Analysis of bridge circuit without overlap, Analysis of bridge with overlap less than 600, Rectifier and inverter characteristics, complete characteristics of rectifier and inverter, Equivalent circuit of HVDC Link.

### MODULE-3: High Voltage DC Transmission – II

Desired features and means of control, control of the direct current transmission link, Constant current control, Constant ignition angle control, Constant extinction angle control, Converter firing- angle control-IPC and EPC, frequency control and Tap changer control, Starting, Stopping and Reversal of power flow in HVDC links.

### MODULE-4: Flexible AC Transmission Systems-I

Types of FACTS Controllers, brief description about various types of FACTS controllers, Operation of 6-pulse converter, Transformer Connections for 12-pulse, 24-pulse and 48-pulse operation, principle of operation of various types of Controllable shunt VAR Generation, Principle of switching converter type shunt compensator, principles of operation of various types of Controllable Series VAR Generation, Principle of Switching Converter type series compensator.

| MODULE-5: Flexible AC Transmission Systems-II | |
|---|---|
| Unified Power Flow Controller (UPFC) – Principle of operation, Transmission Control Capabilities, Independent Real and Reactive Power Flow Control; Interline Power Flow Controller (IPFC) – Principle of operation and Characteristics, UPFC and IPFC control structures (only block diagram description), objectives and approaches of voltage and phase angle regulators | |
| **Total hours:** | 54 |

**Term work:**

1. Develop HVDC Transmission system using mat lab software
2. The steady-state and transient performance of a 12-pulse, 1000 MW (500 kV-2kA) 50/60 Hz HVDC transmission system.
3. FACTS and HVDC Technologies for the Development and Enhancement of Future Power Systems.4.Use of HVDC and FACTS which can be applied in transmission and distribution systems
5. Simulation of various applications using FACTs devices.
6. AC-DC Power flow analysis using FACTS devices.

**Content beyond syllabus:**

1. Design of real-time industrial projects.
2. Application of various compensation techniques in power system.

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Introduction of DC power transmission | CO1 | https://www.cet.edu.in/noticefiles/229_HVDC_NOTE.pdf |
| 2 | Analysis of HVDC converters | CO2 | https://aits-tpt.edu.in/wp-content/uploads/2018/08/HVDC-2-Unit.pdf |
| 3 | Control of HVDC converterand systems | CO3 | https://sari-energy.org/oldsite/PageFiles/What_We_Do/activities/HVDC_Training/Presentations/Day_2/3.HVDC_CONTROLS.pdf |
| 4 | Introduction To Facts | CO4 | https://nptel.ac.in/courses/108/107/108107114/ |
| 5 | Static Series Compensators | CO5 | https://nptel.ac.in/courses/108/107/108107114/ |

**Text Book(s):**

1. Narain G. Hingorani and Laszlo Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, Wiley-Interscience, New Jersey, 2000.
2. E.W. Kimbark, Direct current transmission, Vol. I, Wiley Interscience, New York, 1971.

**Reference Book(s):**

1. K R Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International Publishers, New Delhi, 2007.
2. AnriqueAcha, Claudio R. Fuerte-Esquivel, Hugo Ambriz-Pérez and César Angeles-Camacho, FACTS: Modelling and Simulation in Power Networks, John Wiley & Sons, West Sussex, 2004.
3. R Mohan Mathur and Rajiv K Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, IEEE Press, Wiley-Interscience, New Jersey, 2002.

**Online Resources:**

1. https://nptel.ac.in/courses/108104013,
2. https://nptel.ac.in/courses/108107114

**Web Resources:**

1. https://nptel.ac.in/courses/108/104/108104013/
2. http://www.ee.uidaho.edu/ee/power/ee
3. https://www.powereng.com/our-services/power-delivery/hvdc-fact/
4. https://en.wikipedia.org/wiki/High-voltage_direct_current
5. https://www.ti.com/lit/an/sloa289a/sloa289a.pdf?ts=1592377419880&ref_url=https%253A%252F%2www.google.co.in%252F
7. https://pv-magazine-usa.com/2020/03/31/hvdc-transmission-helps-investors-but-may-not-help-solar/
8. http://www.renewableenergyfocus.com/view/3567/hvdc-transmission-from-energy-source-to-consumer/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | HYBRID ELECTRICAL VEHICLES (PE-IV) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total | Credit | Max Marks | | |
| | L | T | P | hrs | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite**: To Learn about Power Electronic devices, Semiconductor drives, Energy storage systems( Battery, Fuel Cell, Super Capacitor etc).

**Course Objectives:**

1. To understand Importance of Hybrid Electric Vehicles
2. To Know the various drive-train topologies
3. To Learn the operation and configurations of DC & AC Drives
4. To Know the importance of various Energy storage systems and Energy management strategies
5. To provide knowledge about supervisory control of EVs

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

| | |
|---|---|
| **CO 1** | Understand the models to describe hybrid vehicles and their performance (BL-2) |
| **CO 2** | Classify various hybrid drive-train topologies(BL-1) |
| **CO 3** | Understand the various configurations of DC & AC Motor drives. (BL-2) |
| **CO 4** | Understand the different possible ways of energy storage and different strategies related to Energy management strategies. (BL-2) |
| **CO 5** | Understand the mode of operation and control Architecture. (BL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | | | | | | 2 | | | | | | 2 | 3 |
| CO2 | 2 | | | | | | | | | | | | 2 | 2 |
| CO3 | 3 | | 1 | | | | | | | | | | 1 | 2 |
| CO4 | 2 | | | | | | | | | | | | 1 | |
| CO5 | 2 | | | | | | | | | | | | 1 | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| MODULE – 1 | INTRODUCTION TO ELECTRIC VEHICLES |
|---|---|

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

| MODULE -2 | 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

| MODULE-3 | Electric Propulsion unit |
|---|---|

Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives

| MODULE-4 | Energy Storage Systems and Energy Management |
|---|---|

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery, Fuel Cell, Super Capacitor based energy storage and its analysis.
Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies.

| MODULE-5 | Hybrid Vehicle Control Strategy |
|---|---|

| | |
|---|---|
| HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode. | |
| **Total hours:** | **54** |

**Term work:**

Term work contains minimum two group assignments followed by seminars and quiz's

**Content beyond syllabus:**

3. Hybridization of different energy storage devices
4. Mechanics of Electric Vehicles

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Introduction to Electric Vehicles | CO1 | https://nptel.ac.in/content/storage2/courses/108103009/download/M1.pdf<br>https://www.youtube.com/watch?v=KOLBGKMo3zQ |
| 2 | Hybrid Electric Drive-trains | CO2 | https://www.youtube.com/watch?v=oydKVcJqPQ0<br>https://nptel.ac.in/content/storage2/courses/108103009/download/M3.pdf |
| 3 | DC & AC Motor drives | CO3 | https://www.youtube.com/watch?v=1AT1yuQ9awM&list=PLFW6lRTa1g83sIfVY1p1xGqPGYUmXyahx |
| 4 | Energy Storage Systems & Energy Management Strategies | CO4 | https://www.youtube.com/watch?v=j7RaL_XKywk<br>https://nptel.ac.in/content/storage2/courses/108103009/download/M10.pdf |
| 5 | Hybrid Vehicle Control Strategy | CO5 | https://nptel.ac.in/content/storage2/courses/108103009/download/M12.pdf |

**Text Book(s):**

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
3. Electric Vehicle Technology Explained-James Larminie, John Lowry-John Wiley & Sons Ltd,-2003
4. Electric & Hybrid Vehicles-Design Fundamentals-Iqbal Hussain, Second Edition, CRCPress,2011

**Reference Book(s):**

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. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.
3. Iqbal Husain, "Electric and Hybrid Electric Vehicles", CRC Press, 2011.
4. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, WILEY, 2017

**Online Resources / Web References:**

1. https://b-ok.asia/book/1226776/eceb4b
2. https://b-ok.asia/book/3357286/21e776
3. http://ceb.ac.in/knowledge-center/E-BOOKS/Modern%20Electric,%20Hybrid%20Electric%20&%20Fuel%20Cell%20Vehicles%20-%20Mehrdad%20Ehsani.pdf
4. https://b-ok.asia/book/3516646/6fe038
5. https://nptel.ac.in/courses/108/103/108103009/
7. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl
8. https://www.youtube.com/watch?v=11e_d3Q9jEc

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | **RENEWABLE ENERGY CONVERSION SYSTEMS (PE-IV)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | RECS | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:** Nill

**Course Objectives:**

1. To create awareness about various Electric Energy Conversion Systems.
2. Learn the fundamental concepts about solar energy conversion systems and devices
3. To understand the solar thermal conversion systems for high temperature applications.
4. To learn Thermal and Bio-energy conversion systems
5. To Understand the various technologies that are used in WECS
6. To Understand the Fuel cell technology

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

| | |
|---|---|
| **CO 1** | Understand various Electric Energy Conversion Systems (BTL-2) |
| **CO 2** | Analyze the solar thermal conversion system (Also for high temperature applications) (BTL-4) |
| **CO 3** | Analyze the Photovoltaic & Bio-Energy Conversion Systems (BTL-4) |
| **CO 4** | Illustrate the existing Wind Energy Conversion System (BTL-2) |
| **CO 5** | Extend the knowledge about working principle of various Fuel cell technology (BTL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** |
| **CO1** | 3 | 1 | 1 | | | | | | | | | | 1 | |
| **CO2** | 2 | 2 | | | | | | | | | | | 1 | 2 |
| **CO3** | 2 | 1 | | | | | | | | | | | 1 | 1 |
| **CO4** | 2 | 1 | 1 | | | | | | | | | | | 2 |
| **CO5** | 1 | 1 | 1 | | | | | | | | | | 1 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

| **MODULE – 1** | **ELECTRIC ENERGY CONVERSION SYSTEM** |
|---|---|

Generation of electricity using different sources, Transmission and distribution losses, AC to DC and DC to AC conversions, Electric motors: Types, losses, efficiency, Lightning systems, Diesel generating systems.

| **MODULE -2** | **SOLAR THERMAL CONVERSION SYSTEM** |
|---|---|

Relevance of solar thermal power generation; Components of solar thermal power plant, Design and performance, characteristics of different solar concentrator types suitable for thermal power generation

| | |
|---|---|
| **HIGH TEMPERATURE APPLICATIONS:** Types of solar thermal conversion system used in high temperature application, Tracking of solar concentrators; performance characterization of solar concentrators both line focus and point focus, Comparative analysis of the both mode focus system. | |
| **MODULE-3** | **THERMAL ENERGY CONVERSION & BIO-ENERGY CONVERSION SYSTEMS** |
| Thermo-electric generator, Concepts and design considerations of MHD generators, Cycle analysis of MHD systems, Thermionic power conversion and plasma diodes, Thermo chemical Conversion. Bio-energy conversion, bio methanation technology. | |
| **MODULE-4** | **WIND ENERGY CONVERSION SYSTEM (WECS)** |
| Rotor Selection, Annual Energy Output, HAWT, VAWT, Rotor Design Considerations- Number of Blades, Blade Profile -2/3 Blades and Teetering, Coning- Upwind/Downwind, Power Regulation, Yaw System- Tower, Synchronous and Asynchronous Generators and Loads, Integration of Wind Energy Converters to Electrical Networks, Inverters. | |
| **MODULE-5** | **FUEL CELL TECHNOLOGY** |
| Overview of fuel cells, Fuel cell thermodynamics, fuel cell efficiency, Fuel cell characterization, Fuel cell modelling and system integration, Balance of plant, Hydrogen production from renewable sources and storage, life cycle analysis of fuel cells | |
| **Total hours:** | **54** |

**Term work:**

Individual assignment, followed by Quiz and End semester examinations

**Content beyond syllabus:**

Advance energy conversion process

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Electric Energy Conversion Systems | CO1 | https://www.britannica.com/technology/energy-conversio |
| 2 | solar energy conversion systems | CO2 | https://www.appropedia.org/Solar_energy_conversion_system https://www.sciencedirect.com/topics/engineering/thermal-solar-energy-system-technology |
| 3 | Thermal and Bio-energy conversion systems | CO3 | http://www.fao.org/3/T1804E/t1804e06.htm |
| 4 | Wind Energy Conversion Systems | CO4 | https://www.appropedia.org/Wind_energy_conversion_system |
| 5 | Fuel cell technology | CO5 | https://www.hydrogenics.com/technology-resources/hydrogen-technology/fuel-cells/ |

**Text Book(s):**

1. S. S. L. Chang, Energy Conversion, Prentice Hall, 1963
2. R. J. Rosa, Magneto hydrodynamic Energy Conversion, Springer, 1987.
3. V. S. Bagotsky, Fuel Cell Problems and Solutions, John Wiley & Sons, 2009

**Reference Book(s):**

1. Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970
2. Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984

**Online Resources:**

1. https://archive.org/details/energyconversion00chan
2. https://www.trine.edu/books/documents/de_text1.0.0.pdf

**Web Resources:**

3. https://www.youtube.com/watch?v=mpHZWYpKDJg
4. https://www.youtube.com/watch?v=GExTwRNkQBg

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | SWITCHED MODE POWER CONVETERS (PE-V) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** By the end of the course, the student will be able to

1. Understand basic concepts of DC-DC converters
2. Understand the concepts of resonant converters and their classification, various types of multilevel inverters, power conditioners, UPS and filters.
3. Apply various modulation and harmonic elimination techniques over the converters.
4. Analyze the state space modelling of various types of converters.
5. Design inductor and transformer for various power electronic applications.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Remember basic concepts of various converters. -L1 |
| **CO 2** | Understand the problems and to design of various DC-DC converters, advanced converters of SMPCs. -L2 |
| **CO 3** | Evaluate the performance of resonant converters. -L3 |
| **CO 4** | Analyze the performance characteristics of 1-ϕ and 3-ϕ inverters with single/multi levels, power conditioners, UPS and filters. -L3 |
| **CO 5** | Design various applications of the above in Power Systems, EVE, Renewable Energy Systems, etc. -L5 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 2 | 1 | 1 | | | | | | | | | | 1 | 2 | 2 |
| **CO2** | 3 | | 1 | | | | | | | | | | 1 | 1 | 2 |
| **CO3** | 1 | 2 | | | | | | | | | | | | 1 | 2 |
| **CO4** | 2 | 2 | 3 | | | | | | | | | | 1 | 2 | 2 |
| **CO5** | 2 | | 1 | | | | | | | | | | | 2 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: DC-DC Converters**

Principles of step-down and step-up converters – Analysis and state space modelling of Buck, Boost, Buck- Boost and Cuk converters – Numerical Examples

**MODULE -2: Switching Mode Power Converters**

Analysis and state space modelling of flyback, Forward, Luo, Half bridge and full bridge converters- control circuits and PWM techniques – Numerical Examples

**MODULE-3: Resonant Converters**

Introduction- classification- basic concepts- Resonant switch- Load Resonant converters- ZVS, Clamped voltage topologies- DC link inverters with Zero Voltage Switching- Series and parallel Resonant inverters- Voltage control – Numerical Examples

**MODULE-4: DC-AC Converters**

Single phase and three phase inverters, control using various (sine PWM, SVPWM and advanced modulation) techniques, various harmonic elimination techniques- Multilevel inverters- Concepts - Types: Diode clamped- Flying capacitor- Cascaded types- Applications.

**MODULE-5: Power Conditioners, UPS & Filters**

Introduction- Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors.

**Total hours:** 54

**Term work:**
Assignments followed by quizzes

**Content beyond syllabus:**
Real-time Embedded Control Systems

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | state feedback controller and state observer | CO1 | https://nptel.ac.in/content/storage2/courses/108103008/PDF/module9/m9_lec3.pdf |
| 2 | linear and nonlinear systems using phase plane method | CO2 | https://nptel.ac.in/courses/108/106/108106162/ |
| 3 | Analysis of describing functions with non-linearities | CO3 | https://people.unica.it/eliousai/files/2015/10/Describing-Function-analysis-v1.pdf |
| 4 | Optimal control problem | CO4 | https://nptel.ac.in/courses/108/105/108105019/# |
| 5 | Solution of Kalman Filter by duality principle | CO5 | https://nptel.ac.in/content/storage2/courses/101108047/module15/Lecture%2040.pdf https://nptel.ac.in/courses/101/108/101108047/ |

**Text Book(s):**
1. Power Electronics: Essentials and Applications by L. Umanand, Wiley, 2009
2. M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001.
3. Course material on Switched Mode Power Conversion by V Ramanarayanan, Dept. of Electrical Engg. IISc. Bangalore.

**Reference Book(s):**
1. Philip T. Krein, ―Elements of Power Electronics‖, Oxford University Press, 2012
2. Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics converters, Applications and design, 3rd Edition, John Wiley and Sons, 2006
3. M.H. Rashid, Power Electronics circuits, devices and applications, 3rd Edition Prentice Hall of India New Delhi, 2007.

**Online Resources:**
1. https://nptel.ac.in/courses/108108036
2. https://nptel.ac.in/courses/108105180

**Web Resources:**

1. https://www.youtube.com/watch?v=bbm79-UcNN0&list=PLbMVogVj5nJTNkhtkCEKQHhPOr2bpS3za
2. https://www.youtube.com/watch?v=DSvBXXnZv34&list=PLUY5PVaLSLNEKzeQv13ZevTL5AhnQOkWX
3. https://b-ok.asia/book/1193802/dec93b
4. https://b-ok.asia/book/459450/7e89ab

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | ELECTRICAL DISTRIBUTION SYSTEM (PE-V) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** To make the students

1. To know about fundamental aspects of distribution system, principle of distribution substations.
2. To know about classification of various loads.
3. To understand difference between conventional load flow studies of power system and distribution system load flow.
4. To know about evaluation of voltage droop and power loss calculations, distribution automation and management system, SCADA.

**Course Outcomes**: After completing the course, the student should be able to do the following

| | |
|---|---|
| **CO 1** | Understand fundamental aspects of distribution system and various factors affecting the distribution systems. -L2 |
| **CO 2** | Analysis of substations and modelling of loads. -L3 |
| **CO 3** | Understand difference between conventional load flow studies of power system and distribution system load flow. -L2 |
| **CO 4** | Evaluation of voltage drop and power loss calculations and capacitor location and cost analysis.-L3 |
| **CO 5** | Analyse the concepts of SCADA, Automation distribution system and management. -L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 2 | | | 2 | 1 | 2 | | | 1 | | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | | | | 1 | | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | | | | | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 1 | 1 | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 2 | 2 | | 1 | 2 | 1 | 3 | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Distribution System Fundamentals

Brief description about electrical power transmission and distribution systems, Different types of distribution sub-transmission systems, Substation bus schemes, Factors effecting the substation location, Factors effecting the primary feeder rating, types of primary feeders, Factors affecting the primary feeder voltage level, Factors effecting the primary feeder loading.

| MODULE -2: Distribution System Substations and Loads |
|---|
| **Substations:** Rating of a distribution substation for square and hexagonal shaped distribution substation, Service area with ―n‖ primary feeders, K constant, Radial feeder with uniformly and non-uniformly distributed loading. Benefits derived through optimal location of substations.<br>**Loads:** Various types of loads, Definitions of various terms related to system loading, Distribution transformer loading, feeder loading, Relationship between the Load Factor and Loss Factor, Modelling of star and delta connected loads. |
| **MODULE-3: Distribution System Load Flow** |
| Exact line segment model, Modified line model, approximate line segment model, Step-Voltage Regulators, Line drop compensator, Forward/Backward sweep distribution load flow algorithm – Numerical problems |
| **MODULE-4: Voltage Drop and Power Loss Calculation** |
| Analysis of non-three phase primary lines, concepts of four-wire multi-grounded common-neutral distribution system, Percent power loss calculation, Distribution feeder cost calculation methods, Capacitor installation types, Series and Shunt Capacitors, Types of three-phase capacitor-bank connections, Procedure for best capacitor location, Economic justification for capacitors – Numerical problems. |
| **MODULE-5: Distribution Automation** |
| Distribution automation, distribution management systems, distribution automation system functions, Basic SCADA system, Consumer Information Service (CIS) – Geographical Information System (GIS) – Automatic Meter Reading (AMR), Outage management, decision support applications, substation automation, control feeder automation. |
| **Total hours:** 54 |

**Term work:**
Report on SCADA implementation in distribution system

**Content beyond syllabus:**
Smart Distribution System

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Substation bus schemes | CO1 | https://electricaltech.in/different-bus-bar-schemes-in-electrical-substations/ |
| 2 | Radial feeder with uniformly and non-uniformly distributed loading | CO2 | https://testbook.com/electrical-engineering/radial-distribution-system |
| 3 | Forward/Backward sweep distribution load flow algorithm | CO3 | https://research.ijcaonline.org/icaet2017/number5/ICAET2017124.pdf |
| 4 | Series and Shunt Capacitors | CO4 | https://jits.ac.in/wp-content/uploads/2020/02/EHVAC-P.BALAKISHAN-EEE-pdf.pdf |
| 5 | Basic SCADA system | CO5 | https://inductiveautomation.com/resources/article/what-is-scada |

**Text Book(s):**

1. Distribution System Modelling and Analysis, William H. Kersting, CRC Press, Newyork, 2002.
2. Electric Power Distribution System Engineering, TuranGonen, McGraw-Hill Inc., New Delhi, 1986.

**Reference Book(s):**

1. Control and automation of electrical power distribution systems, James Northcote-Green and Robert Wilson, CRC Press (Taylor & Francis), New York, 2007.
2. Biswarup Das, Power distribution Automation, IET publication, 2016.
3. Dr. M. K. Khedkar, Dr. G.M. Dhole, Electric Power Distribution Automation, Laxmi Publications, First edition, 2017.

**Online Resources:**

https://onlinecourses.nptel.ac.in/noc22_ee126/preview

**Web Resources:**

https://www.youtube.com/watch?v=nlFM1q9QPJw&t=57s

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | AUTOMOTIVE ELECTRICAL ENGINEERING (PE-V) | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | AEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To understand the various types of Batteries and their ratings
2. To understand the starting condition and its behavior
3. To understand the various charging systems in Automobiles
4. To learn different Lighting systems in Automobiles
5. To learn electronic engine management system in Automobiles
6. To understand the various electrical and non electrical sensors

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

| | |
|---|---|
| **CO 1** | Compute the efficiency of Batteries through various test's |
| **CO 2** | Understand the working of different starter drive units and their maintenance and the concept of vehicle charging system with its auxiliaries |
| **CO 3** | Understand the dazzling of head light and its preventive methods |
| **CO 4** | Understand the electronic dashboard instruments & onboard diagnostic system |
| **CO 5** | Understand the various sensors used in Automobiles |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 3 | | 1 | | | | 2 | | | | | | 2 | 2 |
| CO2 | 2 | 1 | 1 | | | | | | | | | | | |
| CO3 | 2 | | 1 | | | | | | | | | | 1 | |
| CO4 | 2 | 1 | 2 | | | | | | | | | | 2 | 2 |
| CO5 | 2 | 1 | 1 | | | | | | | | | | 1 | 2 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1**

**BATTERIES ACCESSORIES AND CHARGING SYSTEM**

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging.

Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cutout. Voltage and current regulators, compensated voltage regulator, alternators.

**MODULE -2**

**STARTING SYSTEM**

Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, care and maintenances of starter motor, starter switches.

**MODULE-3**

**LIGHTING**

Lighting system: insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods – Horn, wiper system and trafficator.

**MODULE-4**

**FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS**

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.

**MODULE-5**

**SENSORS AND ACTUATORS**

Types of sensors: sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors, relay.

| | |
|---|---|
| **Total hours:** | **54** |

**Term work:**

Individual Assignments, followed by Quiz's

**Content beyond syllabus:**

1. Advanced charging system in Automobiles

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Construction of lead acid battery | CO1 | https://circuitglobe.com/lead-acid-battery.html https://www.howacarworks.com/basics/how-the-charging-system-works |
| 2 | Principle and construction of starter motor | CO2 | https://www.samarins.com/glossary/starter.html |
| 3 | Lighting system | CO3 | https://what-when-how.com/automobile/lighting-circuit-automobile/ |
| 4 | Automotive electronic engine management system | CO4 | https://www.ukessays.com/essays/engineering/electronic-control-unit-and-engine-management-system-engineering-essay.php |
| 5 | Types of sensors | CO5 | https://www.my-cardictionary.com/electronics/sensors.html |

**Text Book(s):**

1. Tom Weather Jr and Cland C.Hunter, *"Automotive Computers and Control system"*, Prentice Hall Inc., New Jersey.
2. A. Bonnick, *"Automotive Computer Controlled Systems"*, 2011.
3. Young A. P & Griffiths L, *"Automobile Electrical and Electronic Equipments"* English Languages Book Society & New Press, 1990.

**Reference Book(s):**

1. Santini Al, *"Automotive Electricity and Electronics"*, Cengage Learning, 2012.
2. Tom Denton, *"Automotive Electrical and Electronic System"*, SAE International, 2004.
3. William B. Ribbens, *"Understanding Automotive Electronics"*, 6th Edition, Newnes, 2003.
4. BOSCH, *"Automotive Handbook"*, 8th Edition, BENTLEY ROBERT Incorporated, 2011.
5. Norm Chapman, *"Principles of Electricity and electronics for the Automotive Technician"*, Delmar Cengage Learning, 2008.
6. Judge A.W, *"Modern Electrical Equipment of Automobiles"*, Chapman & Hall, London, 1992.

**Online Resources:**

1. https://b-ok.asia/book/526451/802478
2. https://b-ok.asia/book/2161298/3ad7b5

**Web Resources:**

1. https://www.youtube.com/watch?v=hs7bABMtOMI&list=PLyqSpQzTE6M9G2SNxKfsVEjcM9MlJau4F
2. https://www.youtube.com/watch?v=HHgPBMMZ26w

| NARAYANA ENGINEERING COLLEGE::GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | ENERGY AUDIT & DEMAND SIDE MANAGEMENT | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | EMS | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite: Nil**

**Course Objectives:**

1. To learn about energy consumption and situation in India
2. To learn about Energy Management.
3. To learn about Energy Measuring Instruments.
4. To understand the Demand Side Management (DSM).
5. To understand the cost effectiveness for DSM.

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

| | |
|---|---|
| **CO 1** | Understand the importance of energy audit and the basic ideas of conduction an energy audit (BTL-2) |
| **CO 2** | Analyze various techniques of energy management and conservation (BTL-4) |
| **CO 3** | Understand energy efficient methods and power factor improvement techniques (BTL-2) |
| **CO 4** | Analyze demand side management concepts through case study (BTL-4) |
| **CO 5** | Understand various Cost effectiveness test for demand side management programs (BTL-2) |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 1 | | 1 | 2 | | 2 | | | 2 | 1 | | | 1 | 1 |
| CO2 | 1 | 2 | 1 | 1 | | 1 | 1 | | 2 | | 1 | | 2 | 1 |
| CO3 | | 1 | | 1 | | 1 | | | | | | | 2 | 1 |
| CO4 | 1 | 2 | | | | 1 | | | 1 | | | | 1 | 1 |
| CO5 | 1 | 1 | 2 | | | 1 | | | 1 | | | | 1 | 1 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1** **Basic principles of Energy Audit**

Energy audit- definitions, concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes-Energy audit of industries-energy saving potential, energy audit of process industry, thermal power station, building energy audit

**MODULE -2** **Energy management**

**Energy management-I**

Principles of energy management, organizing energy management program, initiating, planning , controlling, promoting, monitoring, reporting.

**Energy management-II**

Energy manger, Qualities and functions , language ,Questionnaire - check list for top management

**MODULE-3** **ENERGY MANAGEMENT FOR LIGHTING AND ENERGY MOTORS**

Good Lighting System Design and Practice, Lighting Control, Lighting Energy Audit

Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit

**MODULE-4** **INTRODUCTION TO DEMAND SIDE MANAGEMENT**

Introduction to DSM, Concept of DSM, Benefits of DSM, Different Techniques of DSM – Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs.

| **MODULE-5** | **ECONOMICS AND COST EFFECTIVENESS TESTS OF DSMPROGRAMS** |
|---|---|

Basic payback calculations, Depreciation, Net present value calculations. Taxes and Tax Credit – Numerical Problems. Importance of evaluation, measurement and verification of demand side management programs. Cost effectiveness test for demand side management programs - Ratepayer Impact Measure Test, Total Resource Cost, Participant Cost Test, Program Administrator Cost Test

| | |
|---|---|
| **Total hours:** | **54** |

**Term work:**

Term work contains assignments ,seminars and quiz

**Content beyond syllabus:**

1. Energy Instruments For Audit

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Energy Audit | CO1 | http://www.opexworks.com/KBase/Energy _Management/Energy_Audit_and _Management/Energy_Audit/Energy _Audit_Types_and_Methodology.htm |
| 2 | Overview of energy management | CO2 | https://beeindia.gov.in/sites/default/files/1Ch3.pdf<br><br>https://www.nrcan.gc.ca/sites/oee.nrcan.gc.ca /files/files/pdf/energy-audit-manual-and-tool.pdf |
| 3 | Energy management for motors | CO3 | https://www.youtube.com/watch?v=T9Vmp3Qo8Mo |
| 4 | Demand side management | CO4 | http://africa-toolkit.reeep.org/modules/Module14.pdf |
| 5 | Cost effective test of DSM | CO5 | https://www.youtube.com/watch?v=P4yfHQWYfLc |

**Text Book(s):**


**1.** Industrial Energy Management Systems**,** Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.

**2.** Fundamentals of Energy Engineering - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.

**Reference Book(s):**

1) Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2) Energy management by Paul o‟ Callaghan, Mc-graw Hill Book company-1/e,1998
3) Energy efficient electric motors by John C. Andreas, Marcel Dekker Inc Ltd-2/e, 1995
4) Energy management hand book by W.C.Turner, john Wiley and sons
5). Energy management and good lighting practice: fuel efficiency- booklet12-EEO

**Online Resources:**

1. http://lab.fs.uni-lj.si/kes/erasmus/Energy%20Management%20Handbook.pdf
2. https://www.bsr.org/reports/bsr-energy-management-handbook.pdf

**Web Resources:**

1. https://freevideolectures.com/
2.https://www.academia.edu/33324894/Energy_Management_Handbook_7th_Ed_Doty_and_Turner_Fairmont_Press_2009--03-Oct-2009-.pdf?auto=download

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**
**Regulation: NECR B.TECH 23**

## MINOR DEGREE (EEE Department)

There is no requirement of CGPA for the registration of a Minor Degree. However, students must have cleared all subjects in their first attempt up to the 2-1 Semester.

## MINORS IN ENERGY SYSTEMS (EEE Department)

| S. No. | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | | Energy Audit and Management | 3 | 0 | 0 | 3 |
| 2 | | Energy Management in Building | 3 | 0 | 0 | 3 |
| 3 | | Energy Storage Technologies | 3 | 0 | 0 | 3 |
| 4 | | Energy Scenario and Energy Policy | 3 | 0 | 0 | 3 |
| 5 | | Waste Energy Management | 3 | 0 | 0 | 3 |
| 6 | | Project in Energy Systems | 0 | 0 | 6 | 3 |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ENERGY AUDIT AND MANAGEMENT | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. Able to understand the basic concepts of Energy Audit and Management, Principles and objectives of Energy management and Basics of Thermal, Electrical energy management
2. Able to apply the fundamental concepts for development of energy management systems
3. Able to Design Energy Audit reports
4. Able to analyze designed energy management systems

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding the Fundamentals of Energy Auditing and Conservation. **-L2** |
| **CO 2** | Analyzing Energy Audit Concepts and Techniques **-L3** |
| **CO 3** | Designing and Implementing Energy Management Programs **-L5** |
| **CO 4** | Managing Thermal Energy and Implementing Energy Conservation Techniques **L4** |
| **CO 5** | Implementing Electrical Energy Management and Conservation **-L4** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | – | – | 2 | – | 3 | – | – | – | – | 2 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | – | 3 | – | – | – | – | 2 | 2 | 3 |
| CO3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | – | 2 | 2 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 2 | – | 3 | – | – | – | – | 2 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 2 | – | 3 | – | – | – | – | 2 | 2 | 3 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction

Basic elements and measurements - Mass and energy balances – Scope of energy auditing industries - Evaluation of energy conserving opportunities.

### MODULE -2: Energy Audit Concepts

Need of Energy audit - Types of energy audit – Energy management (audit) approach - understanding energy costs - Bench marking – Energy performance - Matching energy use to requirement - Maximizing system efficiencies - Optimizing the input energy requirements - Duties and responsibilities of energy auditors- Energy audit instruments - Procedures and Techniques.

### MODULE-3: Principles and Objectives of Energy Management

Design of Energy Management Programs - Development of energy management systems – Importance - Indian need of Energy Management - Duties of Energy Manager - Preparation and presentation of energy audit reports - Some case study and potential energy savings.

| MODULE-4: Thermal Energy Management | |
|---|---|
| Energy conservation in boilers - steam turbines and industrial heating systems - Application of FBC - Cogeneration and waste heat recovery - Thermal insulation - Heat exchangers and heat pumps - Building Energy Management. | |
| **MODULE-5: Electrical Energy Management** | |
| Supply side Methods to minimize supply-demand gap- Renovation and modernization of power plants - Reactive power management – HVDC - FACTS - Demand side - Conservation in motors - Pumps and fan systems – Energy efficient motors. Demand side management. | |
| **Total hours:** | 54 |

**Term work:**
Report submission on Energy Audit of any department class rooms and labs

**Content beyond syllabus:**
Energy Audit software tool

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Basic elements and measurements | CO1 | https://www.slideshare.net/DrPriteeRaotole/functional-elements-of-measurement-system |
| 2 | Types of energy audit | CO2 | https://www.carboncollective.co/sustainable-investing/energy-audit |
| 3 | Development of energy management systems | CO3 | https://www.unido.org/stories/what-energy-management-system |
| 4 | Cogeneration and waste heat recovery | CO4 | https://beeindia.gov.in/sites/default/files/2Ch7.pdf |
| 5 | Reactive power management | CO5 | https://powerline.net.in/2023/01/18/reactive-power-management-2/ |

**Text Book(s):**
1. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980.
2. Energy Management: W.R.Murphy, G.Mckay

**Reference Book(s):**
1. Energy Management Principles: C.B.Smith
2. Efficient Use of Energy : I.G.C.Dryden
3. Energy Economics A.V.Desai
4. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com).

**Online Resources:**
https://nptel.ac.in/courses/108106022

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ENERGY MANAGEMENT IN BUILDING | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. Able to understand the significance of energy management in buildings, Ventilation and Air conditioning aspects, Climate influence, energy usage estimation and technological options for energy management
2. Able to apply the Energy management concepts for building designs
3. Able to analyze different conditions for preparation of efficient energy management system for a building
4. Able to design efficient energy management systems for buildings

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding the Fundamentals of Energy Use in Buildings Apply the Energy management concepts for building designs **-L2** |
| **CO 2** | Analyzing Indoor Environmental Requirements and Their Impact on Energy Use **-L3** |
| **CO 3** | Examining the Role of Climate and Environmental Factors in Building Energy Use **-L3** |
| **CO 4** | Evaluating Energy Utilization and Heat Transfer in Building Envelopes **L4** |
| **CO 5** | Implementing Energy Management Strategies for Buildings **-L5** |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 3 | – | 2 | – | 3 | – | – | – | 2 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | – | 3 | – | – | – | – | 2 | 3 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 1 | – | 3 | – | – | – | – | 2 | 3 | 3 |
| CO4 | 3 | 2 | 2 | 3 | 2 | – | 3 | – | – | – | – | 2 | 3 | 3 |
| CO5 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | – | 2 | – | 3 | 2 | 3 | 3 |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: Overview of the Significance of Energy use and Energy Processes in Building**

Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications – Concepts of energy efficient building.

**MODULE -2: Indoor Environmental Requirement and Management**

Thermal comfort – Ventilation and air quality - Air-conditioning requirement - Visual perception – Illumination requirement - Auditory requirement – Concept of sick building syndrome – Significance in energy management in buildings.

| MODULE-3: Climate |
|---|
| Solar radiation and their influences - The sun-earth relationship and the energy balance on the earth's surface – Climate – Wind - Solar radiation - Temperature – Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings. |
| **MODULE-4: END-USE** |
| Energy utilization and requirements – Lighting and day lighting – End-use energy requirements – Status of energy use in buildings – Estimation of energy use in a building - Heat gain and thermal performance of building envelope – Steady and non steady heat transfer through the glazed window and the wall – Standards for thermal performance of building envelope – Evaluation of the overall thermal transfer – Concepts of window management. |
| **MODULE-5: Energy Management Options** |
| Energy audit and energy targeting – Technological options for energy management – Modifications for energy efficient buildings for Indian conditions. Energy Management for large tower buildings. |
| **Total hours:** 54 |

**Term work:**
Report submission on energy management planning

**Content beyond syllabus:**
Energy management techniques

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Internal and external factors on energy use | CO1 | https://www.sciencedirect.com/science/article/abs/pii/S0378778819329391 |
| 2 | Air-conditioning requirement | CO2 | https://www.slideshare.net/slideshow/air-condition-requirement-in-hospitals/26890977 |
| 3 | Energy impact on the shape and orientation of buildings | CO3 | https://www.mdpi.com/2075-5309/15/8/1359 |
| 4 | Estimation of energy use in a building | CO4 | https://www.sciencedirect.com/science/article/abs/pii/S0360544223008708 |
| 5 | Technological options for energy management | CO5 | https://www.carbontrust.com/our-work-and-impact/guides-reports-and-tools/digital-technologies-for-energy-management-a-buyers-guide |

**Text Book(s):**


1. 1. Heating and Cooling of Buildings – Design for Efficiency, J. Krieder and A. rabl, McGraw Hill, 1994.
2. 2. Mechanical and Electrical Equipment for Buildings, S. M. Guinnes and Reynolds, Wiley, 1989.


**Reference Book(s):**


3. Energy Design for Architects, Shaw, Aee Energy Books, 1991.
4. Energy Conservation in Buildings – Royal Institute of Architecture, Canada.
5. Publication of CBRI, Roorkee – Energy Management in Buildings.

**Web Resources:**
https://faculty.kashanu.ac.ir/file/download/course/1680378354-keith-moss-energy-management-in-buildings-2-edition-spon-press-2005-.pdf

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ENERGY STORAGE TECHNOLOGIES | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** The course aims to:

1. Introduce the fundamentals of energy storage technologies, especially batteries and supercapacitors.
2. Familiarize students with various primary and secondary battery chemistries and their performance parameters.
3. Explore the latest advancements in battery technologies and their integration in modern energy systems.
4. Understand the role of energy storage in supporting renewable energy systems for grid stability and load management.
5. Enable students to analyze and apply supercapacitor technologies for high-power, short-duration energy applications.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding the Basics of Batteries and Their Performance Characteristics -L2 |
| **CO 2** | Analyzing Primary Battery Types and Their Applications -L3 |
| **CO 3** | Exploring Advanced Battery Technologies and Their Applications -L4 |
| **CO 4** | Assessing Energy Storage for Renewable Energy Systems -L4 |
| **CO 5** | Understanding and Applying Supercapacitors in Energy Storage -L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | – | – | 2 | – | 2 | – | – | – | – | 2 | 2 | 3 |
| CO2 | 3 | 3 | – | 2 | 2 | – | 2 | – | – | – | – | 2 | 2 | 3 |
| CO3 | 3 | 2 | 2 | 3 | 2 | – | 3 | – | – | – | – | 3 | 2 | 3 |
| CO4 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | – | – | – | – | 2 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 3 | – | 2 | – | – | – | – | 2 | 2 | 3 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Batteries

Types-battery characteristics - voltage, current, capacity, volumetric energy density, specific energy density, charge rate, cycle life, internal resistance, energy efficiency, shelf life, battery management system, SoC, SoH estimation techniques. Testing of batteries, battery charging method, Factors affecting the battery performance.

### MODULE -2: Primary Batteries

Fabrication, performance aspects, packing and rating of alkaline manganese, silver oxide cells. Lithium primary batteries-Lithium/Manganese Dioxide, Lithium/Carbon Monofluoride, Lithium/Thionyl chloride, Lithium/Sulfur Dioxide, Lithium/Iodine, Lithium-Aluminum/Iron Disulfide.

### MODULE-3: Advanced Batteries

Advanced Lead Acid Battery -design, performance aspects, Pb-Acid batteries for transportation, nickel-metal hydride batteries, zinc- alkaline batteries, ZEBRA Battery (Na/NiCl2) -NaS Battery-Lithium-Ion Battery-Lithium- Polymer Battery, Li-air batteries, Li-S batteries, Sodium -ion batteries.

**MODULE-4: Storage for Renewable Energy Systems**

Solar energy, Wind energy, pumped hydro energy, Energy storage in Micro-grid and Smart grid, Energy Management with storage systems, Battery SCADA, Increase of energy conversion efficiencies by introducing energy storage. Superconducting Magnetic Energy Storage (SMES), charging methodologies, Photo galvanic cells, semiconductor solar batteries (SC-SB), thermo-ionic converter s, dye-sensitized solar cells (DSSC).

**MODULE-5: Supercapacitors and Fuel Cells**

Fundamentals of electrochemical Supercapacitors, electrode and electrolyte interfaces and their capacitances, charge-discharge characteristics, energy/power density, design, fabrication, operation and evaluation, thermal management. Supercapacitors for transportation applications - aqueous and organic based supercapacitors, Pseudo and asymmetric supercapacitors. Advance battery-supercapacitors hybrids for auto, space and marine applications. Fuel Cells working Principle and Construction.

| **Total hours:** | 54 |
|---|---|

**Term work:**
Report submission on any technology simulation.

**Content beyond syllabus:**
Simulation on storage technology

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Testing of batteries | CO1 | https://batteryuniversity.com/article/battery-test-methods |
| 2 | Fabrication of batteries | CO2 | https://www.tmaxcn.com/lithium-battery-production-plant_c190?gad_source=1&gad_campaignid=17328322451&gbraid=0AAAADObAJW0AJ45vrLfjxzKhU1Ryf00w&gclid=Cj0KCQjw64jDBhDXARIsABkk8J67PMLij0uCQdoeAz0bPMaRNBFxR8jzu1D7DinaeiJMUQTvCIt9q6UaAkLmEALw_wcB |
| 3 | Advanced Lead Acid Battery -design | CO3 | https://superiorgraphite.com/applications/lead-acid-batteries/ |
| 4 | Photo galvanic cells | CO4 | https://www.sciencedirect.com/science/article/abs/pii/0038092X75900523 |
| 5 | Fundamentals of electrochemical Supercapacitors | CO5 | https://iopscience.iop.org/article/10.1149/2.F02081IF/pdf#:~:text=The%20very%20feature%20of%20an,devices%20compared%20to%20conventional%20capacitors. |

**Text Book(s):**


1. Dell, Ronald M. Rand and David A. J., “Understanding Batteries”, Royal Society of Chemistry, 2001.
2. Vladimir S. Bagotsky, Alexander M. Skundin, Yurij VM. Volfkovich., “Electrochemical power sources : Batteries, fuel cells, and supercapacitors”, John Wiley & Sons, Inc.,2015.


**Reference Book(s):**


1. Lindon David, “Handbook of Batteries”, McGraw Hill, 2002.
2. Kiehne H. A., “Battery Technology Handbook”, Expert Verlag, Renningen Malsheim, 2003.
3. AuliceScibioh M. and Viswanathan B., “Fuel Cells – Principles and Applications”, University Press, 2006.
4. A.G.Ter-Gazarian, “Energy Storage for Power Systems”, The Institution of Engineering and Technology (IET) Publication, UK, 2011.


**Web Resources:**

https://energydigital.com/top10/top-10-energy-storage-technologies

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ENERGY SCENARIO AND ENERGY POLICY | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** The student able to:

- Understand the basic concepts of Energy scenario and Energy policy
- Apply the concepts to strengthen energy system
- Analyze the different scenarios around the globe
- Implementation of suitable Energy policy for existing systems

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding the Global Energy Scenario and Its Impact on Economic Development-L2 |
| **CO 2** | Analyzing International Energy Policies and Treaties -L3 |
| **CO 3** | Understanding the Indian Energy Scenario and Policy Framework -L2 |
| **CO 4** | Evaluating Global Energy Issues and Energy Security -L3 |
| **CO 5** | Exploring Energy Conservation and Sustainable Development- L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | – | – | – | 3 | 3 | – | – | – | 3 | 2 | 2 | 3 |
| CO2 | 2 | 3 | – | 2 | – | 3 | 3 | 2 | – | – | 2 | 2 | 2 | 3 |
| CO3 | 3 | 2 | – | 2 | – | 3 | 3 | 2 | – | – | 3 | 2 | 2 | 3 |
| CO4 | 2 | 3 | – | 3 | – | 2 | 3 | 2 | – | – | 2 | 2 | 2 | 3 |
| CO5 | 2 | 2 | – | – | – | 2 | 3 | 2 | – | – | 2 | 3 | 2 | 3 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Global Energy Scenario

Role of energy in economic development and social transformation - Energy and GDP - GNP and its dynamics - Energy sources and overall Energy demand and availability - Energy consumption in various sectors and its changing pattern - Depletion of energy sources and impact exponential rise in energy consumption on economies of countries

### MODULE -2: Energy Polices

International Energy Polices of G-8 Countries - G-20 Countries - OPEC Countries - EU Countries - International Energy Treaties (Rio, Montreal, Kyoto) - INDO-US Nuclear Deal.

### MODULE-3: Indian Energy Scenario

Energy resources and Sector wise energy Consumption pattern Impact of energy on economy and development - National and State Level Energy polices and Issues - Status of Nuclear and Renewable Energy and Power Sector reforms. Energy policy 2030

### MODULE-4: Energy Policy

Global Energy Issues - Energy Security - Energy Vision Energy Pricing and Impact of Global Variations Energy Productivity (National and Sector wise productivity).

| MODULE-5: Energy Conservation | |
|---|---|
| Act – 2001 and its features - Electricity Act – 2003 and its features - Energy Crisis - Future energy options - Need for use of new and renewable energy sources - Energy for Sustainable development. | |
| **Total hours:** | 54 |

**Term work:**
Survey report submission on different policies and their impacts on energy

**Content beyond syllabus:**
Different Policies

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Global Energy Trends and Projections | CO1 | https://www.iea.org/reports/world-energy-outlook-2023 |
| 2 | Indian Energy Policy and Regulatory Framework | CO2 | https://powermin.gov.in/en/content/policies |
| 3 | Energy Economics and Pricing Mechanisms | CO3 | https://nptel.ac.in/courses/121106014 |
| 4 | Sustainable Development Goals (SDG 7: Affordable and Clean Energy) | CO4 | https://sdgs.un.org/goals/goal7 |
| 5 | International Energy Agreements and Treaties | CO5 | https://unfccc.int/process-and-meetings/the-paris-agreement |

**Text Book(s):**
1. Energy for a sustainable World: Jose Golden berg, Thomas Johan son, AKN. Reddy, Robert Williams (Wiley Eastern).
2. Energy Policy, B.V. Desai (Wiley Eastern)

**Reference Book(s):**
1. Modeling approach to long term demand and energy implication, J.K.Parikh
2. Energy Policy and Planning, B.Bukhootsow
3. TEDDY Year Book Published by Tata Energy Research Institute(TERI) World Energy Resources, Charles E. Brown, ‘International Energy Outlook’ - EIA annual Publication
4. BEE Reference book: no. 1/2/3/4

**Online Resources:**
https://nptel.ac.in/courses/109106161

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | WASTE ENERGY MANAGEMENT | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** Upon successful completion of this course, the students will be able to:

1. Understand the classifications and characteristics of various types of waste relevant for energy recovery.
2. Learn and analyze different thermo-chemical and bio-chemical waste-to-energy conversion technologies.
3. Explore energy recovery opportunities from waste plastics and industrial waste heat.
4. Evaluate the environmental and health impacts of various waste-to-energy practices.
5. Study real-world case studies of waste-to-energy (WtE) projects and assess their feasibility and effectiveness.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding and Characterizing Different Types of Waste -L2 |
| **CO 2** | Analyzing Thermo-Chemical Waste Conversion Methods and Their Environmental Impacts -L3 |
| **CO 3** | Exploring Bio-Chemical Conversion Technologies for Waste to Energy-L4 |
| **CO 4** | Evaluating Energy Production from Waste Plastics and Waste Heat Recovery-L4 |
| **CO 5** | Analyzing Environmental and Health Impacts of Waste-to-Energy Conversion and Case Studies-L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | – | – | 2 | 3 | 3 | – | – | – | – | 2 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | – | – | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | – | – | 2 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 2 | – | 2 | – | – | – | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | – | 2 | – | 2 | 3 | 3 | – | – | – | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Characterization Of Wastes

Agricultural residues and wastes including animal wastes; industrial wastes; municipal solid wastes. Waste processing types and composition of various types of wastes; Characterization of Municipal Solid Waste, Industrial waste and Biomedical Waste, waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of Municipal solid waste.

### MODULE -2: Thermo Chemical Conversion

Incineration, pyrolysis, gasification of waste using gasifiers, environmental and health impacts of incineration; strategies for reducing environmental impacts. Energy production from wastes through incineration, energy production through gasification of wastes, Energy production through pyrolysis and gasification of wastes, syngas utilization.

| MODULE-3: Bio-Chemical Conversion |
|---|
| Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion biogas production, and present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages. Energy production from wastes through fermentation and trans esterification. Cultivation of algal biomass from waste water and energy production from algae, Energy production from organic wastes through anaerobic digestion and fermentation. |
| **MODULE-4: Energy Production From Waste Plastics, Gas Cleanup Waste, Heat Recovery** |
| Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices. |
| **MODULE-5: Environmental and Health Impacts-Case Studies** |
| Environmental and health impacts of waste to energy conversion, Industrial waste management – Hazardous waste management – E-waste management -EV Batteries – Mobile Chargers - case studies of commercial waste to energy plants, waste to energy- potentials and constraints in India, eco- technological alternatives for waste to energy conversions. |

| **Total hours:** | 54 |
|---|---|

**Term work:**
Report submission on various techniques

**Content beyond syllabus:**
Industry oriented waste energy management

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Waste Classification and Energy Potential | CO1 | https://www.unep.org/resources/report/global-waste-management-outlook-2024 |
| 2 | Thermo-Chemical Conversion (Incineration, Pyrolysis, Gasification) | CO2 | https://nptel.ac.in/courses/121106014 |
| 3 | Anaerobic Digestion and Fermentation | CO3 | https://www.ieabioenergy.com/publications/ |
| 4 | Waste Plastic to Fuel Technology | CO4 | https://www.teriin.org/article/waste-plastic-conversion-fuel |
| 5 | Environmental & Health Impacts of WtE | CO5 | https://www.epa.gov/smm/sustainable-management-materials-non-hazardous-materials-and-waste-management-hierarchy |

**Text Book(s):**


1. Parker, Colin and Roberts, “Energy from Waste – An Evaluation of Conversion Technologies”, Elsevier Applied Science, 1985.
2. Khandelwal, K. C. and Mahdi, S. S., “Biogas Technology - A Practical Hand Book”, Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

**Reference Book(s):**


1. Robert C. Brown, “Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power”, John Wiley and Sons, USA, 2019
2. Sergio Capareda, “Introduction to Biomass Energy Conversions”, CRC Press, USA, 2013.
3. Krzysztof J Ptasinski, “Efficiency of Biomass Energy: An Exergy Approach to Biofuels, Power, and Biorefineries, John Wiley & Sons, USA, 2013.
4. Vesilind, P.A., and Worrell W. A, “Solid Waste Engineering, 2nd Ed”, Cengage India, 2016.


**Online Resources:**

https://nptel.ac.in/courses/121106014

## MINORS IN MICROGRID TECHNOLOGY (EEE Department)

| S. No. | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | | Futuristic Power Systems | 3 | 0 | 0 | 3 |
| 2 | | Power Electronic Converters for Energy Sources | 3 | 0 | 0 | 3 |
| 3 | | Microgrid Power and Control Architecture | 3 | 0 | 0 | 3 |
| 4 | | Microgrid System Design | 3 | 0 | 0 | 3 |
| 5 | | Analysis of Smart Grid Systems | 3 | 0 | 0 | 3 |
| 6 | | Project in Micro Grid Technology | 0 | 0 | 6 | 3 |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | FUTURISTIC POWER SYSTEMS | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To explore the state of the art and future trends in power systems.
2. To understand the technical, economic and social challenges in power system evolution.
3. To realize the role and importance of Microgrids if futuristic power systems.

**Course Outcomes**: Upon successful completion of this course, the learner will be able

| | |
|---|---|
| **CO 1** | To solicit the importance of large scale renewable energy integration with existing grid infrastructure.L1 |
| **CO 2** | To understand the importance and utility of Energy storage systems in futuristic power systems. L2 |
| **CO 3** | To explore large scale micro-grid deployment with RES and ESS integration. L3 |
| **CO 4** | To understand the role of communication and IT Infrastructure in power system and related challenges. L2 |
| **CO 5** | To explore the potential of Microgrids and its importance in Indian context. L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | - | - | 2 | 2 | 3 | - | - | - | - | 2 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 3 | - | 3 | - | - | - | - | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | - | - | 2 | - | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 3 | - | 2 | - | - | 2 | - | 2 | 2 | 2 |
| CO5 | 3 | 2 | - | - | 2 | 3 | 3 | - | - | - | - | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction

Present status of worldwide scenario of electricity generation, transmission and distribution; Energy infrastructure-Resilience and Security; Social, Technical and economic challenges; Major trends driving power system evolution; State of the art technologies in power system.

### MODULE -2: Renewable Energy Integration

Review of renewable energy (RE) resources and systems: Solar- PV, Solar Thermal, Wind, Biomass, Micro-hydro and Fuel Cell, comparison of various RE resources; Renewable Energy Policies and present status of integration with existing grid; Large scale integration of renewable energy-Technical challenges, enabling technologies, International requirements; Renewable energy forecasting

### MODULE-3: Energy Storage Systems (ESS)

Review of energy storage components: Battery, VRB, Ultra-capacitor, Fuel Cells, Pumped Hydro-Storage and flywheels, comparison of ESS technologies; Importance of ESS in futuristic power systems; Aggregated ESS, Distributed ESS; Applications of ESS: Energy Management (Load Leveling and Peak Shifting), Fluctuation Suppression (Intermittency Mitigation), Uninterruptible Power System Low-Voltage Ride Through; Placement of the ESS to Improve Power Quality, Voltage Regulation Using ESS, ESS as Spinning Reserve.

**MODULE-4: Micro-grid and Smart-grid**

Micro-grid evolution: Micro-grid concept, importance in futuristic power system, basic architectures and control, objectives and state of the art technologies; Microgrid as a building block of Smart-grid; Smart-grid concept, Smart Grid versus conventional electrical networks, Smart-grid infrastructure, Smart Grid communication system and its cyber security, International standard IEC 61850 and its application to Smart-grid; Microgrids /smart grid and Electric Vehicles integration. Technical, Economic, Environmental and Social Benefits of Microgrid Operation. Microgrids for Rural Electrification, Review of Microgrid Best Practices through Case Studies: Strategic Planning, Operations: Commercial and Financial Considerations; Technical and Social Context.

**MODULE-5: Communication and IT infrastructure**

Requirements of Communication and IT infrastructure in futuristic power systems: various communication protocols, comparison of performance; IEEE standard: IEEE 802.11 Mesh Networking, IEEE 802.15.4-Wireless Sensor Networks; Communications Technologies for Smart metering; Cyber security issues and mitigation techniques.

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**
Survey report submission

**Content beyond syllabus:**
Restructured Power system

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Large-scale Renewable Energy Integration with Grid | CO1 | https://nptel.ac.in/courses/108105159 |
| 2 | Energy Storage Systems (ESS) in Modern Power Grids | CO2 | https://www.coursera.org/learn/energy-storage |
| 3 | Microgrids with Renewable Energy and ESS Integration | CO3 | https://ieeexplore.ieee.org/courses/details/71541 |
| 4 | Communication and IT Infrastructure in Smart Grids | CO4 | https://nptel.ac.in/courses/108105159 |
| 5 | Microgrids in the Indian Context – Policies & Case Studies | CO5 | https://www.teriin.org/article/microgrids-rural-electrification-india |

**Text Book(s):**

1. Microgrids Architectures and Control Edited by Nikos Hatziargyriou, IEEE and Wiley, 2014
2. Energy Storage for Sustainable Microgrid by David Wenzhong Gao, Elsevier, 2015
3. Introduction to the Smart Grid- Concepts, Technologies and Evolution by Salman K. Salman, IET, 2017
4. Energy Storage Systems and Components by Alfred Rufer, CRC Press, 2018

**Reference Book(s):**

1. Energy Efficiency and Renewable Energy Handbook Edited by D. Yogi Goswami and Frank Kreith, 2nd Edition- 2016, CRC
2. Clean Energy Microgrids, Edited by Shin'ya Obara and Jorge Morel IET, 2017
3. Hybrid-Renewable Energy Systems in Microgrids- Integration, Developments and Control edited by Hina Fathimaby *et al*., Elsevier WoodHead Publishing, 2018
4. Smart Microgrids: Lessons from Campus Microgrid Design and Implementation edited by Hassan Farhangi, CRC Press 2017

**Online Resources:**

1. NPTEL Web Course on: DC Microgrid And Control System Prof. Avik Bhattacharya, IIT Roorkee

**Web Resources:**

1. NPTEL Web Course on Electronics and Distributed Generation Dr. Vinod John Department of Electrical Engineering IISc Bangalore
2. NPTEL Web Course on Introduction to Smart Grid, PROF. N.P. PADHY Department of Electrical Engineering IIT Roorkee PROF. PREMALATA JENA Department of Electrical Engineering
3. NPTEL Web Course on Electric vehicles and Renewable energy, Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha and Prof. L Kannan, IIT Madras

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | POWER ELECTRONIC CONVERTERS for ENERGY SOURCES | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To illustrate the design philosophies used in the domain of microgrid power converters.
2. To explore the control implementations in power converters for voltage, current and power regulation for various DC and AC energy sources

**Course Outcomes**: Upon successful completion of this course, the learner will be able to

| | |
|---|---|
| **CO 1** | Select and size various passive and active components for power converters L3 |
| **CO 2** | Design power converters used with DC energy resources with their control implementation L5 |
| **CO 3** | Design power converters used with AC energy resources with their control implementation L5 |
| **CO 4** | Understand the design considerations of power conditioning unit for ESS, SPV and Wind applications. L2 |
| **CO 5** | Understand the design and selection aspects of various auxiliary systems and components used in PCUs L2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 2 | - | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| CO4 | 2 | 2 | 3 | 2 | 2 | - | 2 | - | - | - | - | 1 | 3 | 2 |
| CO5 | 2 | 2 | 2 | - | 2 | - | 2 | - | - | - | - | 1 | 3 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Selection of components for Power Electronics Converters (PEC)

Selection and Sizing of capacitors and magnetic components for PECs, design of Magnetic Components; Selection and sizing of Power Devices, Commonly used software tools for selection and sizing; Heatsink- selection and sizing.

### MODULE -2: Design and Control of DC-DC Converters

Design of Buck and Boost converters, Design examples; Design of Bidirectional Converters. Design of gate driver circuits; Review of DC-DC converter modelling; Closed loop PI controller design for buck and boost converters; Current control mode and voltage control mode.

### MODULE-3: Design and Control of DC-AC converters

Design of Inverter for standalone applications; Design of grid connected Inverter with different grid synchronization strategies- ZCD, PLL; Strategies for Control of voltage, current and power output.

### MODULE-4: Design of PCU for SPV and Wind Application

| |
|---|
| Various topologies of Power Converter Unit (PCU) for SPV and Wind energy systems. Design considerations of PCU for SPV and Wind energy Systems and Design Examples. |
| **MODULE-5: Design of PCU for ESS Applications and Design of Auxiliary System and Interfaces** |
| Design consideration for BDC converter based PCU for batteries and Ultra-capacitors. Design of current and voltage sensor interfaces; Design considerations for auxiliary power supplies; Design of protection and snubber components: Introduction to Digital Signal Processors (DSP) and microcontroller interfaces. |

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**
MATLAB Simulation based report on any converter

**Content beyond syllabus:**
Multilevel converters applications

**Self-Study:**
Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Design and Simulation of Power Converters in MATLAB/Simulink | CO1 | https://matlabacademy.mathworks.com/details/simulink-onramp/getting-started |
| 2 | MPPT Techniques for PV Systems (Perturb & Observe, Incremental Conductance) | CO2 | https://www.coursera.org/learn/solar-energy |
| 3 | Battery Management Systems and Power Conditioning for Energy Storage | CO3 | https://www.edx.org/course/energy-storage-systems |
| 4 | Gate Driver Design and Protection for Power Electronics | CO4 | https://www.ti.com/power-management/power-supply-design/seminars.html |
| 5 | IGBTs, MOSFETs and SiC Devices for High-Efficiency Converters | CO5 | https://training.infineon.com/elearning |

**Text Book(s):**


1. Power Electronic Converters for Microgrids by Suleiman M. Sharkh, Mohammad A. Abusara, Georgios I. Orfanoudakis Babar Hussain, IEEE and Wiley, 2014
2. Control Circuits In Power Electronics Practical Issues In Design And Implementation Edited by Miguel Castilla, IET, 2016
3. Control and Dynamics in Power Systems and Microgrids by Lingling Fan, CRC Press, 2017
4. Integrated Power Electronic Converters and Digital Control, by Ali Emadi, Alireza Khaligh, Zhong Nie, and Young Joo, Lee 2009, CRC Press.


**Reference Book(s):**


1. Cooperative Synchronization in Distributed Microgrid Control by Ali Bidram, Vahidreza Nasirian Ali Davoudi, and Frank L. Lewis, Springer, 2017

2. Hybrid-Renewable Energy Systems in Microgrids- Integration, Developments and Control edited by Hina Fathimaby et al., Elseiver WoodHead Publishing, 2018
3. Smart Microgrids- Lessons from Campus Microgrid Design and Implementation edited by Hassan Farhangi, CRC Press 2017
4. Energy Storage Systems and Components by Alfred Rufer, CRC Press, 2018
5. Microgrids Design and Implementation edited by Antonio Carlos Zambroni de Souza and Miguel Castilla, Springer, 2019
6. Microgrids Architectures and Control Edited by Nikos Hatziargyriou, IEEE and Wiley, 2014
7. Energy Storage for Sustainable Microgrid by David Wenzhong Gao, Elsevier, 2015

**Online Resources:**

https://www.monolithicpower.com/en/learning/mpscholar/power-electronics/power-electronic-applications/renewable-energy-systems?srsltid=AfmBOory6c9UmTzkpXM2QvBixSuV4AiOAPei6Wl-BSdYArw3EQE_724m

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MICROGRID POWER and CONTROL ARCHITECTURE | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To study various power and control architectures adopted in DC and AC Microgrids.
2. To explore various control strategies used in power control
3. To take insight into operations stability and protection issues related to Microgrids

**Course Outcomes**: Upon successful completion of this course, the learner will be able to

| | |
|---|---|
| **CO 1** | Understand various types Microgrids based on applications, power and control architecture. L2 |
| **CO 2** | Illustrate various power control strategies adopted in DC, AC and Hybrid Microgrids L3 |
| **CO 3** | Compare and contrast various control architectures used DC, AC and Hybrid Microgrids also various aspects related to stability in Microgrids L4 |
| **CO 4** | Illustrate the various operational challenges in Microgrids L3 |
| **CO 5** | Comprehend the various aspects related to the stability in Microgrids L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 1 | - | - | - | 2 | - | - | - | - | 2 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 2 | - | 2 | - | - | - | - | 3 | 3 | 3 |
| CO4 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | - | 1 | - | - | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | - | 3 | - | - | - | - | 3 | 3 | 3 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Microgrid Power Architecture

Types of Microgrid system, AC and DC and Hybrids Microgrids, Application based Suitability of Microgrid type; Review of power architecture of various Microgrids deployed world-wide. Comparison of various Microgrid power architectures.

### MODULE -2: AC Microgrid and Control Architecture

Black-start operation, Grid Synchronisation- various Grid synchronization methods, Grid forming and grid following operations; Power Control- Real and reactive power control in AC Microgrid, simple droop control and other variants of droop control, Unit Power Flow Control, Feeder power flow control and Mixed mode control, source optimization; Centralized, decentralised, distributed and hierarchical control architecture, Local and system / supervisory level control strategies, Multi Agent System (MAS) Based Control; Control approaches used in AC Microgrids deployed worldwide. Microgrid standards IEEE 1547 series. Communication in AC Microgrids

### MODULE-3: DC Microgrid and Control Architecture

Power sharing in DC Microgrids, source optimization; Control approaches: Centralized, decentralised, distributed and hierarchical control architecture. Control approaches used in hybrid Microgrids. Communication in DC/Hybrid Microgrids

**MODULE-4: Operational Control in Microgrids**

Energy management in Microgrids, coordinated control, load management, grid synchronisation and islanding, Anti-islanding schemes; Various Architectural and Operational Challenges in Microgrid, Optimal operation of Microgrids.

**MODULE-5: Microgrid Stability & Protection**

Steady-state and dynamic stability in AC and DC Microgrids, Methods to improve the stability in Microgrids; introduction to small signal and large signal stability analysis in Microgrids. Fault scenarios in DC and AC Microgrids, Protection in DC and AC Microgrids, adaptive protection, Fault current source (FCS) based protection; Protection challenges in islanded and autonomous modes of operation and ways to mitigate.

| **Total hours:** | 54 |
|---|---|

**Term work:**
Report submission on various control algorithms

**Content beyond syllabus:**
Advanced control strategies

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Energy Management Systems in Microgrids | CO1 | https://www.nrel.gov/docs/fy20osti/75414.pdf |
| 2 | Control Strategies for AC and DC Microgrids | CO2 | https://ieeexplore.ieee.org/document/9397127 |
| 3 | Communication Architectures in Microgrid Control | CO3 | https://www.sciencedirect.com/science/article/pii/S2352484721000764 |
| 4 | Modeling and Simulation of Microgrids using MATLAB/Simulink | CO4 | https://www.youtube.com/playlist?list=PL3o9D2vF2tv8lgChSWhLz6iFzQ9dDRUld |
| 5 | Cybersecurity in Microgrid Control Systems | CO5 | https://ieeexplore.ieee.org/document/8403806 |

**Text Book(s):**


1. Microgrids Design and Implementation edited by Antonio Carlos Zambroni de Souza and Miguel Castilla, Springer, 2019
2. Microgrids Architectures and Control Edited by Nikos Hatziargyriou, IEEE and Wiley, 2014
3. Cooperative Synchronization in Distributed Microgrid Control by Ali Bidram, Vahidreza Nasirian Ali Davoudi, and Frank L. Lewis, Springer, 2017
4. Control Circuits In Power Electronics Practical Issues In Design And Implementation Edited by Miguel Castilla, IET, 2016

**Reference Book(s):**

1. Control and Dynamics in Power Systems and Microgrids by Lingling Fan, CRC Press, 2017
2. Hybrid-Renewable Energy Systems in Microgrids- Integration, Developments and Control edited by Hina Fathimaby et al., Elseiver WoodHead Publishing, 2018
3. Urban DC Microgrid Intelligent Control and Power Flow Optimization by Manuela Sechilariu and Fabrice Locment, 2016 Elsevier
4. Integrated Power Electronic Converters and Digital Control, by Ali Emadi, Alireza Khaligh, Zhong Nie, and Young Joo, Lee 2009, CRC Press.
5. Island Power Systems by Lukas Sigrist, Enrique Lobato, Francisco M. Echavarren Ignacio Egido, and Luis Rouco, CRC Press, 2016

**Online Resources:**

1. NPTEL Web Course on: DC Microgrid and Control System Prof. Avik Bhattacharya, IIT Roorkee
2. NPTEL Web Course on Electronics and Distributed Generation Dr. Vinod John Department of Electrical Engineering IISc Bangalore

**Web Resources:**

1. NPTEL Web Course on Introduction to Smart Grid, PROF. N.P. PADHY Department of Electrical Engineering IIT Roorkee PROF. PREMALATA JENA Department of Electrical Engineering
2. NPTEL Web Course on Electric vehicles and Renewable energy, Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha and Prof. L Kannan, IIT Madras

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MICROGRID SYSTEM DESIGN | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. To illustrate the design philosophies used in the domain of Microgrid.
2. To explore the selection of power and control architecture of Microgrids
3. To study the design aspects of AC Microgrid, DC Microgrid and their auxiliary systems

**Course Outcomes**: Upon successful completion of this course, the learner will be able to

| | |
|---|---|
| **CO 1** | Select and size various Microgrid energy resources L3 |
| **CO 2** | Select the power and control architecture of the Microgrid L3 |
| **CO 3** | Select and design the Microgrid's communication architecture. L3 |
| **CO 4** | Illustrate the design aspects DC and AC Microgrids with their control strategies. L4 |
| **CO 5** | Illustrate the implementation of the Microgrid islanding detection and anti-islanding scheme/ blackstart operation L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO3 | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Selection/ Sizing of Microgrid Energy Resources

Factors affecting the selection and sizing of energy resources for Microgrid applications, dependency on type of loads connected, Selection/ Sizing: Renewable energy resources, Energy Storage components. Hybrid combination of RES and ESS.

### MODULE -2: Selection of Power and Control Architecture

Factors affecting the selection of Microgrid power and control architecture; Design Consideration for control implementation; Sensors: Selection of sensors and design of sensor Interfaces, design of control Interfaces. Design considerations for DSP/ Microcontroller interfaces.

### MODULE-3: Selection and Design of Communication Architecture

Design considerations for selection of communication network for Microgrid applications; Design and implementation of communication links/ interfaces. Microg4controller programming for Data transfer on communication network. Practical design considerations for Communication networks.

### MODULE-4: Design of DC and AC Microgrid

Design DC Power Conditioning Units for RES and ESS, Unidirectional and Bidirectional Converter design, implementation of Control loop with DSP; Programming for Power sharing and Energy Management algorithms; Design of Protection system for DC Microgrid Design AC Power Conditioning Units for RES and ESS, Unidirectional and Bidirectional Converter design, implementation of Control loop with DSP; Grid Synchronization. Programming for Power sharing and Energy Management algorithms; Design of Protection system for AC Microgrid.

**MODULE-5: Islanding in Microgrids**

Selection and implementation of Islanding detection and anti-islanding scheme; Black- start and Autonomous operations in Microgrids

**Total hours:** 54

**Term work:**

Report submission on various design techniques of microgrid

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Distributed Energy Resource (DER) Sizing and Optimization | CO1 | https://nptel.ac.in/courses/108/108/108108122/ |
| 2 | Microgrid Control Strategies (Primary, Secondary, Tertiary) | CO2 | https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/ |
| 3 | Microgrid Communication and Cybersecurity | CO3 | https://nptel.ac.in/courses/108/108/108108148/ |
| 4 | AC vs DC Microgrids – Architecture and Applications | CO4 | https://www.youtube.com/watch?v=Va7A7mXXFeI |
| 5 | Islanding Detection and Black Start Techniques | CO5 | https://ieeexplore.ieee.org/document/8465990 |

**Text Book(s):**

1. Microgrids Design and Implementation edited by Antonio Carlos Zambroni de Souza and Miguel Castilla, Springer, 2019
2. Microgrids Architectures and Control Edited by Nikos Hatziargyriou, IEEE and Wiley, 2014
3. Power Electronic Converters For Microgrids by Suleiman M. Sharkh, Mohammad A. Abusara, Georgios I. Orfanoudakis Babar Hussain, IEEE and Wiley, 2014

**Reference Book(s):**

1. Energy Storage for Sustainable Microgrid by David Wenzhong Gao, Elsevier, 2015
2. Cooperative Synchronization in Distributed Microgrid Control by Ali Bidram, Vahidreza Nasirian Ali Davoudi, and Frank L. Lewis, Springer, 2017
3. Energy Efficiency and Renewable Energy Handbook Edited by D. Yogi Goswami and Frank Kreith, 2nd Edition- 2016, CRC
4. Control Circuits In Power Electronics Practical Issues In Design And Implementation Edited by Miguel Castilla, IET, 2016
5. Hybrid-Renewable Energy Systems in Microgrids- Integration, Developments and Control edited by Hina Fathimaby et al., Elseiver WoodHead Publishing, 2018

6. Urban DC Microgrid Intelligent Control and Power Flow Optimization by Manuela Sechilariu and Fabrice Locment, 2016 Elsevier
7. Integrated Power Electronic Converters and Digital Control, by Ali Emadi, Alireza Khaligh, Zhong Nie, and Young Joo, Lee 2009, CRC Press.

**Online Resources:**

1. https://nptel.ac.in/courses/108/108/108108122/
2. https://nptel.ac.in/courses/108/108/108108148/

**Web Resources:**

1. https://ieeexplore.ieee.org/document/8465990

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ANALYSIS of SMART GRID SYSTEMS | | | | | | | R2023 |
| | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** By the end of the course, students will be able to:

1. Understand the fundamental architecture and functionalities of smart grids.
2. Learn various modeling and simulation tools for analyzing smart grid systems.
3. Study the operational strategies and performance evaluation of smart grids.
4. Investigate the role and impact of Distributed Generation (DG) in smart grid environments.
5. Explore planning and design strategies for integrating DG with smart grid infrastructure.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understand the analysis and planning of smart grids L2 |
| **CO 2** | Evaluate the tools for modeling and analysis of smart grid L3 |
| **CO 3** | Analyze and synthesize the smart grid operation L4 |
| **CO 4** | Assess the influence of distributed generation in smart grid on power systems L4 |
| **CO 5** | Understand the analysis and planning of Distributed Generation in Smart Grid L2 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction

Conventional power systems and Smart grid, definition of smart grid, need for smart grid, Smart grid architecture, smart grid domains, enablers of smart grid, Communication architecture and protocols for smart grid, smart grid priority standards and regulation, smart-grid activities in India.

### MODULE -2: Systems of non linear equations

Fixed point iteration, Newton Raphson Iteration, Continuation methods, Power system application: power flow, regulating transformer, Fast decoupled load flow, PV curves and continuation power flow, three phase power flow

### MODULE-3: Smart Grid Security analysis

Concept of security, Security analysis and monitoring, factors affecting power system security, detection of network problems, an overview of security analysis. Contingency analysis for generator and line outages by Interactive Linear Power Flow (ILPF) method, Fast decoupled inverse Lemma based approach, network sensitivity factors, Contingency selection, concentric

| |
|---|
| relaxation and bounding. |
| **MODULE-4: Smart Grid Operation and Planning** |
| Economic Dispatch, Optimal Power Flow, Load forecasting, Operation of smart grid system, Load Dispatch Centre functions, preventive, Emergency and Restorative, control objectives of a smart distribution system, Operational bottlenecks in smart grid. Planning Aspects of smart grid, Planning and operation Standards. |
| **MODULE-5: Distributed Generation in Smart Grid** |
| Renewable-based Distributed generations, Energy Storage Technologies, Modeling, Control of energy storage system, Short- mid -long term application of energy storage system in smart grids. |

| | |
|---|---|
| **Total hours:** | 54 |

**Term work:**
Report submission on different types of analysis in smart grid

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Smart Grid Architecture and Planning | CO1 | https://nptel.ac.in/courses/108/108/108108148/ |
| 2 | Modeling Tools for Smart Grids (Simulink, OpenDSS, GridLAB-D) | CO2 | https://sourceforge.net/projects/electricdss/ |
| 3 | Smart Grid Operation and Demand Response | CO3 | https://www.coursera.org/learn/smart-grid |
| 4 | Distributed Generation (DG) Integration in Smart Grids | CO4 | https://nptel.ac.in/courses/108/107/108107113/ |
| 5 | Cybersecurity and Communication in Smart Grids | CO5 | https://smartgrid.ieee.org/ |

**Text Book(s):**


1. Muhammad Kamran, Fundamentals of Smart Grid Systems, Academic Press, 2022
2. Mariesa L Crow, Computetional methods for Electric Power Systems, CRC Press, NW, 2016, 3rd Edition.
3. Francisco D´ıaz-Gonz´alez, Andreas Sumper and Oriol Gomis-Bellmunt, Energy Storage in Power Systems, John Wiley & Sons Ltd, 2016


**Reference Book(s):**


1. Prabha Kundur, Power System Stability and Control, McGraw Hill Education, 2006, 1st Edition.
2. Math H. J. Bollen, Fainan Hassan, Integration of Distributed Generation in the Power System, Wiley, 2011
3. A. Mahaboob Subahani, G. R. Kanagachidambaresan, M. Kathiresh, Integration of

Renewable Energy Sources with Smart Grid, Willey, 2021
4. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, Smart Grid: Technology and Applications, John Wiley & Sons, 2015, 1st Edition.
5. Ali Keyhani, Design of smart power grid renewable energy systems, Wiley, 2019, 3rd Edition. Other

**Online Resources:**
https://nptel.ac.in/courses/108/104/108104052/

# DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
## Regulation: NECR B.TECH 23

### OPEN ELECTIVES (Offered by EEE to other Departments)

**From JNTUA for R23:**

| S. No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | OE-I | | Electrical Safety Practices and Standards | 3 | 0 | 0 | 3 |
| 2 | OE-II | | Renewable Energy Sources | 3 | 0 | 0 | 3 |
| 3 | OE-III | | Smart Grid Technologies | 3 | 0 | 0 | 3 |
| 4 | OE-IV | | Electric Vehicles | 3 | 0 | 0 | 3 |

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **ELECTRICAL SAFETY PRACTICES AND STANDARDS (OE-I)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. **To provide foundational knowledge of electrical hazards, shock prevention, and personal safety**, emphasizing awareness and risk mitigation techniques.
2. **To introduce various electrical safety components and protective devices**, focusing on their roles in preventing electrical accidents.
3. **To analyze grounding and bonding practices**, enabling students to design and evaluate effective earthing systems for safety assurance.
4. **To impart practical knowledge of safety procedures and practices** in residential, commercial, and industrial electrical installations and operating environments.
5. **To familiarize students with major electrical safety standards and regulations**, such as IEEE, NEC, OSHA, and Indian Electricity Rules, ensuring students understand legal and professional responsibilities.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding the Fundamentals of Electrical Safety -L2 |
| **CO 2** | Identifying and Applying Safety Components -L3 |
| **CO 3** | Analyzing Grounding Practices and Electrical Bonding L3 |
| **CO 4** | Applying Safety Practices in Electrical Installations and Environments- L4 |
| **CO 5** | Evaluating Electrical Safety Standards and Regulatory Compliance -L5 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO1** | 3 | 2 | | | 2 | 2 | 2 | 2 | | 1 | | 2 | | |
| **CO2** | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | | 1 | | 2 | | |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 2 | 2 | | | 1 | | 2 | | |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | | |
| **CO5** | 2 | 2 | | | 2 | 3 | 2 | 3 | | 2 | 2 | 2 | | |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction To Electrical Safety

Fundamentals of Electrical safety-Electric Shock- physiological effects of electric current - Safety requirements –Hazards of electricity- Arc - Blast- Causes for electrical failure.

### MODULE -2: Safety Components

Introduction to conductors and insulators- voltage classification -safety against over voltages- safety against static electricity-Electrical safety equipment‘s - Fire extinguishers for electrical safety.

### MODULE-3: Grounding

| |
|---|
| General requirements for grounding and bonding- Definitions- System grounding-Equipment grounding - The Earth - Earthing practices- Determining safe approach distance-Determining arc hazard category. |
| **MODULE-4: Safety Practices** |
| General first aid- Safety in handling hand held electrical appliances tools- Electrical safety in train stations-swimming pools, external lighting installations, medical locations-Case studies. |
| **MODULE-5: Standards For Electrical Safety** |
| Electricity Acts- Rules & regulations- Electrical standards-NFPA 70 E-OSHA standards-IEEE standards-National Electrical Code 2005 – National Electric Safety code NESC-Statutory requirements from electrical inspectorate |

| | |
|---|---|
| **Total hours:** | 54 |

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Physiological effects of electric current | CO1 | https://www.wikilectures.eu/w/Physiological_effect_of_electric_current |
| 2 | Electrical safety equipment‘s | CO2 | https://www.powerandcables.com/product/electrical-safety/ |
| 3 | Earthing practices | CO3 | https://www.geeksforgeeks.org/electrical-engineering/earthing/ |
| 4 | Electrical safety in train stations | CO4 | news.railanalysis.com/article-electrical-safety-in-railway-system/ |
| 5 | National Electric Safety codes | CO5 | https://en.wikipedia.org/wiki/National_Electrical_Safety_Code |

**Text Book(s):**

1. Massimo A.G.Mitolo, ―Electrical Safety of Low-Voltage Systems‖, McGraw Hill, USA, 2009.
2. Mohamed El-Sharkawi, ―Electric Safety - Practice and Standards‖, CRC Press, USA, 2014

**Reference Book(s):**

1. Kenneth G.Mastrullo, Ray A. Jones, ―The Electrical Safety Program Book‖, Jones and Bartlett Publishers, London, 2nd Edition, 2011.
2. Palmer Hickman, ―Electrical Safety-Related Work Practices‖, Jones & Bartlett Publishers, London, 2009.
3. Fordham Cooper, W., ―Electrical Safety Engineering‖, Butterworth and Company, London, 1986.
4. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, ―Electrical Safety Hand book, McGraw-Hill, New York, USA, 4th edition, 2012.

**Online Resources:**

https://www.services.bis.gov.in/php/BIS_2.0/BISBlog/national-electrical-code-of-india-2023/

**Web Resources:**

https://www.esfi.org/workplace-safety/industry-codes-regulations/the-national-electrical-code-nec/

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| III-B.Tech | **RENEWABLE ENERGY SOURCES (OE-II)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| II | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. **To introduce the fundamental principles and operating mechanisms** of various renewable energy sources such as solar, wind, geothermal, biomass, ocean, and fuel cells.
2. **To provide knowledge on resource assessment and site selection criteria** for effective deployment of renewable energy systems.
3. **To analyze the influencing factors affecting energy conversion and measurement** in different renewable technologies.
4. **To enable students to design and evaluate solar PV and wind energy systems**, including the orientation, configuration, and turbine types.
5. **To encourage the application of renewable energy technologies** in power generation and to promote sustainability and energy security.

**Course Outcomes**: At the end of the course the student will be able to

| | |
|---|---|
| **CO 1** | Understand principle operation of various renewable energy sources. L1 |
| **CO 2** | Identify site selection of various renewable energy sources. L2 |
| **CO 3** | Analyze various factors affecting on solar energy measurements, wind energy conversion techniques, Geothermal, Biomasss, Tidal Wave and Fuel cell energies L3 |
| **CO 4** | Design of Solar PV modules and considerations of horizontal and vertical axis Wind energy systems. L5 |
| **CO 5** | Apply the concepts of Geo Thermal Energy, Ocean Energy, Bio mass and Fuel Cells for generation of power. L4 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO1** | 3 | 2 | | | 2 | 1 | 3 | | | 1 | | 2 | | |
| **CO2** | 3 | 2 | | 2 | 2 | 1 | 3 | | | 1 | | 2 | | |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 2 | 3 | | | 1 | 1 | 2 | | |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 1 | 3 | | 1 | 1 | 1 | 2 | | |
| **CO5** | 3 | 2 | 2 | 2 | 3 | 2 | 3 | | 1 | 1 | 1 | 2 | | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: Solar Energy**

Solar radiation - beam and diffuse radiation, solar constant, Sun at Zenith, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, storage of solar energy-thermal storage.

**MODULE -2: PV Energy Systems**

Introduction, The PV effect in crystalline silicon basic principles, the film PV, Other PV technologies, Solar PV modules from solar cells, mismatch in series and parallel connections design and structure of PV modules, Electrical characteristics of silicon PV cells and modules, Stand-alone PV system configuration, Grid connected PV systems.

**MODULE-3: Wind Energy**

Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades; wind data and energy estimation and site selection considerations.

**MODULE-4: Geothermal Energy**

Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

**MODULE-5: Miscellaneous Energy Technologies**

**Ocean Energy:** Tidal Energy-Principle of working, Operation methods, advantages and limitations. Wave Energy-Principle of working, energy and power from waves, wave energy conversion devices, advantages and limitations.

**Bio mass Energy:** Biomass conversion technologies, Biogas generation plants, Classification, advantages and disadvantages, constructional details, site selection, digester design consideration

**Fuel cell:** Principle of working of various types of fuel cells and their working, performance and limitations.

| **Total hours:** | 54 |
|---|---|

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Sun at Zenith angle | CO1 | https://sacs.aeronomie.be/info/sza.php |
| 2 | The PV effect in crystalline silicon basic principles | CO2 | https://www.geeksforgeeks.org/physics/photovoltaic-cell/ |
| 3 | Basic components of wind energy conversion systems | CO3 | https://www.herofutureenergies.com/blog/wind-energy-systems/ |
| 4 | Advantages, disadvantages and application of geothermal energy | CO4 | https://www.greenmatch.co.uk/blog/2014/04/advantages-and-disadvantages-of-geothermal-energy |
| 5 | Biogas generation plants in INDIA | CO5 | https://www.globalmethane.org/documents/16.Ag2.1.Dhussa.pdf |

**Text Book(s):**

1. G. D. Rai, ―Non-Conventional Energy Sources‖, 4th Edition, Khanna Publishers, 2000.
2. Chetan Singh Solanki ―Solar Photovoltaics fundamentals, technologies and applications‖ 2nd Edition PHI Learning Private Limited. 2012.

**Reference Book(s):**

1. Stephen Peake, ―Renewable Energy Power for a Sustainable Future‖, Oxford International Edition, 2018.
2. S. P. Sukhatme, ―Solar Energy‖,3rd Edition, Tata Mc Graw Hill Education Pvt. Ltd, 2008.
3. B H Khan , ― Non-Conventional Energy Resources‖, 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011.
4. S. Hasan Saeed and D.K.Sharma,―Non-Conventional Energy Resources‖,3rd Edition, S.K.Kataria& Sons, 2012.
5. G. N. Tiwari and M.K.Ghosal, ―Renewable Energy Resource: Basic Principles and Applications‖, Narosa Publishing House, 2004.

**Online Resources:**

1. https://nptel.ac.in/courses/103103206

**Web Resources:**

1. https://nptel.ac.in/courses/108108078

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | **SMART GRID TECHNOLOGIES (Open Elective- III)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:**

1. **To introduce the concept, need, and evolution of smart grids** in the context of modern power systems.
2. **To impart knowledge on wide-area monitoring systems (WAMS)** and synchrophasor technologies for enhanced grid situational awareness.
3. **To explain smart metering and Advanced Metering Infrastructure (AMI)** for efficient energy management and consumer participation.
4. **To analyze the role of Information and Communication Technology (ICT)** in the development and operation of smart grids.
5. **To enable students to design and implement smart grid applications** with a focus on cybersecurity, interoperability, and automation.

**Course Outcomes**:

| | |
|---|---|
| **CO 1** | Understanding the Concept and Evolution of Smart Grids. L2 |
| **CO 2** | Analyzing Wide Area Monitoring System and Synchrophasor Technology. L4 |
| **CO 3** | Applying Smart Metering and Advanced Metering Infrastructure (AMI) Concepts. L3 |
| **CO 4** | Evaluating Information and Communication Technology (ICT) Systems in Smart Grids. L5 |
| **CO 5** | Designing Smart Grid Applications and Cybersecurity Measures. L6 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO1** | 3 | 2 | | | 2 | 1 | 2 | | | 1 | | 2 | | |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | 1 | 1 | 1 | 2 | | |
| **CO3** | 3 | 2 | 2 | 2 | 3 | 1 | 2 | | 1 | 2 | 1 | 2 | | |
| **CO4** | 3 | 2 | 2 | 2 | 3 | 1 | 1 | | 1 | 2 | 1 | 2 | | |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | | |

1: Low, 2-Medium, 3- High

**COURSE CONTENT**

**MODULE – 1: Introduction to Smart Grid**

Evolution of Electric Grid – Need for Smart Grid – Difference between conventional & smart grid – Overview of enabling technologies – International experience in Smart Grid deployment efforts – Smart Grid road map for India – Smart Grid Architecture.

**MODULE -2: Wide Area Monitoring System**

Fundamentals of Synchro phasor Technology – concept and benefits of Wide Area Monitoring System – Structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC) – Road Map for Synchrophasor applications (NAPSI) – Operational experience and Blackout analysis using PMU - Case study on PMU.

| |
|---|
| **MODULE-3: Smart Meters** |
| Features and functions of Smart Meters – Functional specification – category of Smart Meters – Automatic Meter Reading (AMR) and Advanced Metering Infrastructure (AMI) drivers and benefits – AMI protocol – Demand Side Integration: Peak load, Outage and Power Quality management. |
| **MODULE-4: Information and Communication Technology** |
| Overview of Smart Grid Communication system – Modulation and Demodulation Techniques: Radio Communication – Mobile Communication – Power Line Communication – Optical Fibre Communication – Communication Protocol for Smart Grid. |
| **MODULE-5: Smart Grid Applications and Cyber Security** |
| Applications : Overview and concept of Renewable Integration – Introduction to distributed generation - Role of Protective Relaying in Smart Grid – House Area Network – Advanced Energy Storage Technology: Flow battery – Fuel cell – SMES – Super capacitors – Plug – in Hybrid electric Vehicles - Cyber Security: Security issues in DG, Distribution Automation, AMI, Electric Vehicle Management Systems – Approach to assessment of smart grid cyber security risks – Methodologies. Cyber Security requirements – Smart Grid Information Model. |

| | |
|---|---|
| **Total hours:** | 54 |

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | Difference between conventional & smart grid | CO1 | https://www.tutorialspoint.com/difference-between-conventional-grid-and-smart-grid |
| 2 | Structure and functions of Phasor Measuring Unit | CO2 | https://en.wikipedia.org/wiki/Phasor_measurement_unit |
| 3 | Category of Smart Meters | CO3 | https://www.vvdntech.com/blog/understanding-smart-meters-global-standards-types-benefits-and-challenges/ |
| 4 | Overview of Smart Grid Communication system | CO4 | https://www.nist.gov/programs-projects/smart-grid-communications-0 |
| 5 | Role of Protective Relaying in Smart Grid | CO5 | https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1003&context=ece_present |

**Text Book(s):**

1. James Momoh, "SMART GRID : Fundamentals of Design and Analysis", John Wiley and Sons, New York, 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & Sons, New Jersey, 2012.

**Reference Book(s):**

1. Power Grid Corporation of India Limited, "Smart Grid Primer", 1st Edition, Power Grid Corporation of India Limited, Bangalore, India, 2013.
2. Fereidoon.P.Sioshansi, "Smart Grid – Integrating Renewable, Distributed and Efficient Energy", 1st Edition, Academic Press, USA, 2011.
3. Stuart Borlase, "Smart Grids: Infrastructure, Technology and Solutions", 1st Edition, CRC

Press Publication, England, 2013.
4. Phadke A G, Thorp J S, "Synchronized Phasor Measurements and Their Applications", 1st Edition, Springer, Newyork, 2012.

**Online Resources:**
https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1003&context=ece_present

**Web Resources:**
https://www.ti.com/video/6044129349001

| NARAYANA ENGINEERING COLLEGE:GUDUR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| IV-B.Tech | **ELECTRIC VEHICLES (Open Elective -IV)** | | | | | | | R2023 |
| Semester | Hours / Week | | | Total hrs | Credit | Max Marks | | |
| | L | T | P | | C | CIE | SEE | TOTAL |
| I | 3 | 0 | 0 | 54 | 3 | 30 | 70 | 100 |

**Pre-requisite:**

**Course Objectives:** To make the student

1. Remember and understand the differences between conventional Vehicle and Electric Vehicles, electro mobility and environmental issues of EVs.
2. Analyze various EV configurations, parameters of EV systems and Electric vehicle dynamics.
3. Analyze the basic construction, operation and characteristics of fuel cells and battery charging techniques in HEV systems.
4. Design and analyze the various control structures for Electric vehicle.

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

| | |
|---|---|
| **CO 1** | To understand and differentiate between Conventional Vehicle and Electric Vehicles, electro mobility and environmental issues of EVs. -L2 |
| **CO 2** | Understand Various dynamics of Electric Vehicles. -L2 |
| **CO 3** | To remember and understand various configurations in parameters of EV system and dynamic aspects of EV. -L1 |
| **CO 4** | To analyze fuel cell technologies in EV and HEV systems. -L3 |
| **CO 5** | To analyze the battery charging and controls required of EVs. -L3 |

**CO-PO Mapping**

| CO | PO | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO1** | 3 | 2 | | | 2 | 2 | 3 | | | 1 | | 2 | | |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | | 1 | | 2 | | |
| **CO3** | 3 | 2 | 2 | 2 | 3 | | | | | 1 | 1 | 2 | | |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 1 | 2 | | | 1 | 1 | 2 | | |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 1 | 2 | | 1 | 2 | 1 | 2 | | |

1: Low, 2-Medium, 3- High

## COURSE CONTENT

### MODULE – 1: Introduction to EV Systems and Energy Sources

Past, Present and Future of EV - EV Concept- EV Technology- State-of-the Art of EVs- EV configuration- EV system- Fixed and Variable gearing- Single and multiple motor drive- In-wheel drives- EV parameters: Weight, size, force and energy, performance parameters. Electro mobility and the environment- History of Electric power trains- Carbon emissions from fuels- Green houses and pollutants- Comparison of conventional, battery, hybrid and fuel cell electric systems.

### MODULE -2: EV Propulsion and Dynamics

Choice of electric propulsion system- Block diagram- Concept of EV Motors- Single and multi-motor configurations- Fixed and variable geared transmission- In-wheel motor configuration- Classification - Electric motors used in current vehicle applications - Recent EV Motors- Vehicle load factors- Vehicle acceleration.

### MODULE-3: Fuel Cells

Introduction of fuel cells- Basic operation- Model - Voltage, power and efficiency- Power plant system – Characteristics- Sizing - Example of fuel cell electric vehicle - Introduction to HEV- Brake specific fuel consumption - Comparison of Series-Parallel hybrid systems- Examples.

**MODULE-4: Battery Charging and Control**

**Battery charging:** Basic requirements- Charger architecture- Charger functions- Wireless charging- Power factor correction.

**Control:** Introduction- Modeling of electro mechanical system- Feedback controller design approach- PI controller‘s designing- Torque-loop, Speed control loop compensation- Acceleration of battery electric vehicle.

**MODULE-5: Energy Storage Technologies**

Role of Energy Storage Systems- Thermal- Mechanical-Chemical- Electrochemical- Electrical - Efficiency of energy storage systems- Super capacitors-Superconducting Magnetic Energy Storage (SMES)- SOC- SoH -fuel cells - G2V- V2G- Energy storage in Micro-grid and Smart grid- Energy Management with storage systems- Battery SCADA

| **Total hours:** | 54 |
|---|---|

**Self-Study:**

Contents to promote self-Learning:

| SNO | Topic | CO | Reference |
|---|---|---|---|
| 1 | State-of-the Art of EVs | CO1 | https://www.mdpi.com/2079-9292/13/17/3578 |
| 2 | Choice of electric propulsion system-Block diagram | CO2 | https://www.sciencedirect.com/topics/engineering/electric-propulsion |
| 3 | Introduction of fuel cells | CO3 | https://www.cedengineering.com/userfiles/Introduction%20to%20Fuel%20Cells.pdf |
| 4 | Wireless charging-Power factor correction | CO4 | https://www.sciencedirect.com/science/article/pii/S2772671124003450 |
| 5 | Role of Energy Storage Systems- Thermal-Mechanical-Chemical-Electrochemical-Electrical | CO5 | https://www.sciencedirect.com/topics/engineering/electrochemical-energy-storage |

**Text Book(s):**

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001,1st Edition

2. Ali Emadi, ―Advanced Electric Drive Vehicles‖, CRC Press, 2017,1st Edition

**Reference Book(s):**

1. Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC Press 2021, 3rd Edition. 2. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt,‖ Energy Storage in Power Systems‖ Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016,1st Edition 3. A.G.Ter-Gazarian, ―Energy Storage for Power Systems‖, the Institution of Engineering and Technology (IET) Publication, UK, (ISBN – 978-1-84919-219-4), Second Edition, 2011.

4. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, ―Modern Elelctric, Hybrid Elelctric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2004,1st

| |
|---|
| Edition<br>5. James Larminie, John Lowry, ―Electric Vehicle Technology Explained‖, Wiley, 2003,2nd Edition. |
| **Online Resources:**<br>https://nptel.ac.in/courses/108/102/108102121/ |
| **Web Resources:**<br>https://nptel.ac.in/syllabus/108103009 |