

SYLLABUS
FOR
FOUR-YEAR B. TECH PROGRAMME
IN
ELECTRICAL ENGINEERING



NAAC – A Grade

DEPARTMENT OF ELECTRICAL ENGINEERING
COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous and Constituent College of BPUT, Odisha)

Techno Campus, MahalaxmiVihar, Ghatikia,

Bhubaneswar-751029, Odisha, INDIA

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Department of Electrical Engineering

POs FOR UG COURSE

Programme Outcomes(PO)

| | |
|--------------|--|
| PO 1 | Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems. |
| PO 2 | Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| PO 3 | Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| PO 4 | Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO 5 | Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| PO 6 | The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| PO 7 | Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO 8 | Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| PO 9 | Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO 10 | Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| PO 11 | Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| PO 12 | Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

Abbreviations Used:**L = Lectures****P = Practical or Laboratory****IA = Internal Assessment****T = Tutorial****PA = Practical Assessment****EA = End-Semester Assessment****1st SEMESTER**

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|----------------------------|--------------|--|---------------------|---|---|-------------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Basic Science Course | UBSPH111 | Physics | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 2 | Basic Science Course | UBSMH102 | Mathematics-I | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 3 | Engineering Science Course | UESEE113 | Basic Electrical Engineering | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 4 | Basic Science Course | ULCPH111 | Physics Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 5 | Engineering Science Course | ULCEE113 | Basic Electrical Engineering Lab | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
| 6 | Engineering Science Course | ULCME114 | Workshop\Basic Manufacturing Practices Lab | 1 | 0 | 4 | 3 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 17.5 | | | | 600 |
| 7 | Mandatory Course | | Induction Programme | | | | 0 | | | | |

2nd SEMESTER

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|------------------------------|--------------|---------------------------------|---------------------|---|---|--------|---------------|----|-----|-------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Basic Science Course | UBSCH101 | Chemistry | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 2 | Basic Science Course | UBSMH202 | Mathematics-II | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 3 | Engineering Science Course | UESCS103 | Programming for Problem Solving | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Humanities & Social Sciences | UHSMH205 | English | 2 | 0 | 0 | 2 | 30 | 70 | 0 | 100 |
| 5 | Basic Science | ULCCH101 | Chemistry Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |

| | | | | | | | | | | | |
|---|----------------------------|----------|-------------------------------------|---|---|---|-------------|---|---|-----|------------|
| | Course | | | | | | | | | | |
| 6 | Engineering Science Course | ULCCS103 | Programming for Problem Solving Lab | 0 | 0 | 4 | 2 | 0 | 0 | 100 | 100 |
| 7 | Engineering Science Course | ULCME104 | Engineering Graphics and Design Lab | 1 | 0 | 4 | 3 | 0 | 0 | 100 | 100 |
| 8 | HS | ULCMH204 | English Lab | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 20.5 | | | | 800 |

3rd SEMESTER

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|---------------------------|--------------|--------------------------------------|---------------------|---|---|-----------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Core Course | UPCEE301 | Electrical Circuit Analysis | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course | UPCIE302 | Analog Electronic Circuit | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Core Course | UPCEE302 | Electrical Machines-I | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 4 | Engg. Science Course | UPCEE303 | Electromagnetic Fields | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Basic Science Course | UBSMH301 | Mathematics-III | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 6 | Humanities Science Course | UHSMH211 | Engineering Economics | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 7 | Lab Course | ULCIE301 | Analog Electronic Circuit Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCEE302 | Electrical Machines-I Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 23 | | | | 800 |

4th SEMESTER

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|--------------|--------------|-----------------------|---------------------|---|---|--------|---------------|----|----|-------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Core Course | UPCIE401 | Digital System Design | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course | UPCEE402 | Electrical Machine-II | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |

| | | | | | | | | | | | |
|----|--|----------|----------------------------|---|---|---|-------------|----|----|-----|------------|
| 3 | Core Course | UPCEE403 | Measurement Techniques | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Engg. Science Course | UESIE301 | Signal and Systems | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Humanities Science Course | UHSMH212 | Organizational Behavior | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Lab Course | ULCIE401 | Digital System Design Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 7 | Lab Course | ULCEE402 | Electrical Machine-II Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCEE403 | Measurement Techniques Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 9 | Mandatory Course | UMCCE401 | Environmental Science | | | | 0 | 30 | 70 | 0 | 100 |
| | | | Total | | | | 20.5 | | | | 900 |
| 10 | Summer Internship programme (4 to 8 weeks) is mandatory as per AICTE rule | | | | | | | | | | |

5th SEMESTER

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|----------------------|---------------|--|---------------------|---|---|--------|---------------|----|----|-------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Core Course | UPCEE501 | Electrical Power Transmission and Distribution | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course | UPCEE502 | Power Electronics | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Core Course | UPCEE503 | Control Systems-I | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Core Course | UPCEE504 | Microprocessors and Microcontrollers | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Programme Elective-I | i) UESIE404 | i. Fundamentals of Communication Theory | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | ii) UPEEE502 | ii. Sensors and Transducers | | | | | | | | |
| | | iii) UPEEE503 | iii. Electrical energy Conservation and Auditing | | | | | | | | |
| 6 | Open Elective-I | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |

| | | | | | | | | | | | |
|---|------------|----------|---|---|---|---|-------------|---|---|-----|------------|
| 7 | Lab Course | ULCEE501 | Power Electronics Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCEE502 | Control Systems Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 9 | Lab Course | ULCEE503 | Microprocessors and Microcontrollers Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 22.5 | | | | 900 |

6th SEMESTER

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|--|--------------|---------------------------------------|---------------------|---|---|-----------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Core Course | UPCEE601 | Power System Operation and Control | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course | UPCEE602 | Electric Drives | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Programme Elective-II | UPEEE601 | i. Renewable Energy Systems | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | UPEEE602 | ii. Electric and Hybrid Vehicles | | | | | | | | |
| | | UPEEE603 | iii. Special Electric Machines | | | | | | | | |
| 4 | Programme Elective-III | UPEEE604 | i. High Voltage Engineering | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | UPCIE602 | ii. Digital Signal Processing | | | | | | | | |
| | | UPEEE606 | iii. Electrical Engineering Materials | | | | | | | | |
| 5 | Open Elective-II | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Lab Course | ULCEE601 | Power System Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 7 | Lab Course | ULCEE601 | Electric Drives Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCEE601 | Design and Simulation Laboratory | 0 | 0 | 4 | 2 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 20 | | | | 800 |
| 9 | Summer Internship programme (4 to 8 weeks) is mandatory as per AICTE rule | | | | | | | | | | |

7th SEMESTER

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|---------------------------|---------------|---|---------------------|---|---|-----------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Programme Elective-IV | i)UPEEE701 | i. Power System Protection & Switchgear | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | ii)UPEEE702 | ii. Power System Dynamics and Control | | | | | | | | |
| 2 | Programme Elective-V | i)UPEEE703 | i. Control Systems - II | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | ii)UPEEE704 | ii. Control System Design | | | | | | | | |
| | | iii) UPEEE705 | iii. EHVAC Transmission | | | | | | | | |
| 3 | Open Elective-III | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Open Elective-IV | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Humanities Science Course | UHSMH701 | Entrepreneurship Development | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Project Course | UPREE701 | Project Stage-1 | 0 | 0 | 6 | 3 | 0 | 0 | 100 | 100 |
| 7 | Seminar | USEEE701 | Internship Seminar | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 19 | | | | 700 |

8th SEMESTER

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|-----------------------|--------------|---|---------------------|---|---|--------|---------------|----|----|-------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Programme Elective-VI | i)UPEEE801 | i. Power Quality and Custom Power Devices | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | ii)UPEEE802 | ii. HVDC and FACTs for Transmission Systems | | | | | | | | |
| | | iii)UPEEE803 | iii. Advanced Electric Drives | | | | | | | | |

| | | | | | | | | | | | |
|---|------------------|-------------|-----------------------------------|---|---|----|-----------|----|----|-----|------------|
| | | iv)UPEEE804 | iv. Industrial Electrical Systems | | | | | | | | |
| 2 | Open Elective-V | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Open Elective-VI | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Project Course | UPREE801 | Project Stage-2 | 0 | 0 | 14 | 7 | 0 | 0 | 100 | 100 |
| 5 | Core Course | UPCEE801 | Comprehensive Viva Voce | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 17 | | | | 500 |

| Semester | Sem -1 | Sem -2 | Sem -3 | Sem -4 | Sem -5 | Sem -6 | Sem -7 | Sem -8 | Total |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| Credits | 17.5 | 20.5 | 23 | 20.5 | 22.5 | 20 | 19 | 17 | 160 |

ELECTIVE SUBJECTS OFFERED BY ELECTRICAL ENGINEERING DEPARTMENT:

1. Renewable Energy Systems
2. Electric & Hybrid Vehicles
3. Industrial Electrical Systems
4. Electrical Engineering Materials
5. Control System Design
6. Power Station Engineering and Economy
7. Electrical Energy Conservation and Auditing
8. Advanced Signal Processing

| Semester Wise Credits Break Up | | | | | | | | |
|--------------------------------|-------------------|---------------|---------------------|------------|------------------|---------------|------------------|-------|
| Subject Type | Professional Core | Basic Science | Engineering Science | Humanities | Program Elective | Open Elective | Project /Seminar | Total |
| Semester | | | | | | | | |
| 1 st | | 9.5 | 8 | | | | | 17.5 |
| 2 nd | | 9.5 | 8 | 3 | | | | 20.5 |
| 3 rd | 13 | 4 | 3 | 3 | | | | 23 |
| 4 th | 14.5 | | 3 | 3 | | | | 20.5 |
| 5 th | 16.5 | | | | 3 | 3 | | 22.5 |

| | | | | | | | | |
|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| 6th | 11 | | | | 6 | 3 | | 20 |
| 7th | | | | 3 | 6 | 6 | 4 | 19 |
| 8th | | | | | 3 | 6 | 8 | 17 |
| Total | 55 | 23 | 22 | 12 | 18 | 18 | 12 | 160 |

Semester I (First year)

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|--------------|--------------|--------------|---------------------|---|---|--------|---------------|----|----|-------|
| | | | | L | T | P | | IA | EA | PA | Total |

| | | | | | | | | | | | |
|----------|----------------------------|----------|--|---|---|---|-------------|----|----|-----|------------|
| 1 | Basic Science Course | UBSPH101 | Physics | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 2 | Basic Science Course | UBSMH102 | Mathematics-I | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 3 | Engineering Science Course | UESEE103 | Basic Electrical Engineering | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 4 | Engineering Science Course | UESME104 | Workshop\Basic Manufacturing Practices | 1 | 0 | 0 | 1 | 30 | 70 | 0 | 100 |
| 5 | Basic Science Course | ULCPH101 | Physics Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 6 | Engineering Science Course | ULCEE102 | Basic Electrical Engineering Lab | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
| 7 | Engineering Science Course | ULCME103 | Workshop\Basic Manufacturing Practices Lab | 0 | 0 | 4 | 2 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 17.5 | | | | 700 |
| 8 | Mandatory Course | | Induction Programme | | | | 0 | | | | |

Course Outcomes

At the end of this course, students will demonstrate the ability to

1. Enhance the fundamental knowledge in Physics and its application relevant to various streams of Engineering and Technology.
2. Understand interaction of light with matter through interference, diffraction and be able to distinguish ordinary light with a laser light and to realize propagation of light polarization.
3. Understand various crystal systems and their structures elaborately through optical fibers.
4. Understand basic knowledge of quantum mechanics.

Module 1: (16 Hours)

Classical Dynamics: Newton's laws of motion, generalized coordinates, constraints, Principle of virtual work, D' Alembert's Principle, Lagrangian, Action principle, Lagrange equation of motion (no derivation) and its application to Simple Harmonic oscillator and simple pendulum.

General properties of Matter: Stress, Strain, Hooks' law, Young's modulus.

Oscillation & Waves: Simple Harmonic Oscillation, damped harmonic oscillation, forced oscillator, resonance, coupled oscillation, concept of wave and wave equation.

Optics: Concept of interference, two source interference pattern, Biprism, Michelson Interferometer & measurement of wavelength. Diffraction: Huygens principle, Fresnel & Fraunhofer diffraction, Zone plate, Plane diffraction grating (formula only).

Module 2: (12 Hours)

Solid State Physics: Crystalline and amorphous solid, unit cell, Miller Indices, Reciprocal lattice, Bragg's law, Brillouin's zone, concept of fermions, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distribution function (only statement and formula), Concept of Fermions and Bosons. Classification of materials: metals, semiconductor and insulator in terms of band theory.

LASER and Fibre Optics: Principle and application, stimulated emission, population inversion, Lasing material (solid and gas), He-Ne laser, Rubi- LASER, Application of LASER (Engineering Application), Principle of optical fibre and its application to communication.

Module 3: (12 Hours)

Electromagnetism: Student will be familiarized with some basics used in vector calculus prior to development of Maxwell's electromagnetic wave equations. No proof of theorems and laws included in this unit expected- statement and interpretation should sufficient.

a) Vector calculus: gradient of scalar field, divergence, curl of vector field (Only Physical significance) Gauss divergence theorem, Stoke's theorem, Green's theorem (Only Statements) and applications.

b) Gauss's law of electrostatics in free space and in a medium and application (Only statements) electric displacement (D) magnetic Induction (B), Amperes circuital law (Only statements), displacement

current, Faraday's law of electromagnetic induction (Only statements), Biot Savarts Law (Only statements), Maxwell's four electromagnetic equations, Wave equation for E and B fields in vacuum, Electromagnetic energy, Poynting vector (no derivation).

Quantum Physics: Elementary concepts of quantum physics formulation to deal with physical systems.

a) Need for Quantum Physics-Historical overviews, Particle aspects of radiation- Black body radiation, photoelectric effect, Compton scattering, pair production. (No derivations), Wave aspect of particles- matter wave, de Broglie Hypothesis, Heisenberg Uncertainty principles- Statement, Interpretation and application to H-atom, Harmonic oscillator to calculate ground state energy.

b) Basic features of Quantum mechanics- Transition from deterministic to probabilistic, States of system- Wave function, probability density, superposition principle, observables and operators, expectation values. Schrodinger equation- Time dependent and time independent, wave packets.

Text Books:

1. L. Maharana, P. K. Panda, S. N. Dash, B. Ojha, Lectures in Engineering Physics, Pearson.

Reference Books:

1. An Introduction to Mechanics -D. Klippner & R. Kolenkow, TMH
2. Concepts of Modern Physics - Arthur Beiser.
3. Electricity & Magnetism -E. M. Purecell
4. Engineering Physics by D. K. Bhattacharya and Poonam Tandon, Oxford University Press
5. Engineering Physics by D. R. Joshi, Mc Graw Hill
6. Introduction to Electrodynamics- David J. Griffiths, PHI Publication
7. Optics- A. K. Ghatak
8. Physics-I for engineering degree students- B. B. Swain and P. K. Jena.
9. Quantum Mechanics -Powel & Craseman.
10. Quantum Physics - Gasiorowicz

Mathematics-I (3-1-0)

Code-UBSMH102

Course Outcomes

On successful completion of this course, the students will be able to:

1. Apply the principles of differential calculus to solve a variety of practical problems in engineering and applied sciences.
2. Possess fundamental understanding of Fourier series and be able to give Fourier expansions of a function,

3. Apply the principles of vector calculus to solve a variety of basic problems in engineering and applied science,
4. Solve a variety of first order and higher order differential equations selecting from a variety of techniques covered in the syllabus.

Module 1: (10 Hours)

Calculus: Asymptote, Curvature, Convergence of sequence and series, tests for convergence, power series, Taylor's series, Fourier series.

Partial differentiation, Taylor's theorem for function of two variables, Maxima and Minima for function of two variables.

Module 2: (10 Hours)

Vector differential calculus: vector and scalar functions and fields, Derivatives, Curves, tangents and arc length, gradient, divergence, curl.

Vector integral calculus: Line Integrals, Green Theorem, Surface integrals, Gauss theorem and Stokes Theorem.

Module 3: (10 Hours)

Differential Equation: Differential Equation: First order differential equations, Separable Equation, Exact differential equation, linear differential equation, Bernoulli's equation and application to Electrical circuits.

Linear differential equation of second and higher order, Homogeneous equation with constant co-efficient, Euler-Cauchy equations, Solution by undetermined co-efficient, Solutions by variation of parameters, Modelling of electric circuits.

Module 4: (10 Hours)

Series solution of differential equations, Power series method, Legendre equation and Legendre polynomials.

Laplace transformation and its use in getting solution to differential equations, Convolution, Integral Equations.

Text Books:

1. Differential Calculus by Santi Narayan and Mittal, Chapters 14, 15 Publication.
2. Advanced Engineering Mathematics by E. Kreyszig, Tenth Edition, Wiley.
3. Higher Engineering Mathematics by B. V. Raman, McGraw Hills Education.

Reference Books:

1. Engineering Mathematics by Pal and S. Bhunia, Oxford Publication.
2. Ordinary and Partial Differential equations by J. Sinha Roy and S. Padhy, Kalyani Publishers.
3. Advance Engineering Mathematics by P. V. O'Neil, Cengage.

Basic Electrical Engineering (3-1-0)

Code -UESEE103

This is a foundation course aimed to expose the students the basic and under-lying principles of Electrical circuits, Electro-mechanical energy conversion and Measurements.

Course Outcomes

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

1. Understand and analyse basic electric and magnetic circuits.
2. Analysis of Transient condition in DC circuit.
3. Understand the basic of various types of electrical machines and measurements.
4. Explain the under-laying principle of generation, transmission and distribution of the electrical power.

Module 1: (10 Hours)

Fundamentals of Electric Circuits: Fundamentals of electrical circuit, Ohm's law, Kirchhoff's laws, series and parallel connections, Electric Power and sign conventions, circuit elements and their characteristics. Practical voltage and current sources. Source Conversion.

Resistive Network Analysis: node voltage and mesh current methods, super node and super mesh methods, delta-star and star-delta conversions, superposition principle, Thevenin's and Norton's theorems. maximum power transfer.

Module 2: (10 Hours)

Single phase AC circuits: Single phase emf generation, Representation of sinusoidal waveforms, average, effective, peak and rms values, j operators, phasor concept, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel) Instantaneous Power in AC Circuits, Real power, reactive power, apparent power, Power Factor, Power triangle, Complex Power.

Three-phase AC circuits: Three phase emf generation, Delta-star and star- delta conversions, voltage and current relations in star and delta connections. solution of the three phase circuits with balanced voltage and balanced load conditions, phasor diagram, measurement of power in three phase circuits.

Transient Analysis: Writing differential equations for circuits, DC steady state solutions of first order circuits.

Module 3: (10 Hours)

Electrical Measuring instruments: Introduction, PMMC Ammeters and Voltmeters with extension of range, Moving-Iron Ammeters and Voltmeters, Dynamometer type Wattmeter, Energy meter.

Magnetic circuits: MMF, flux, reluctance, inductance. Review of Ampere Law, Biot Savart Law. Magnetic field, Electricity and Magnetism, B-H characteristics and hysteresis loss, series and parallel magnetic circuits.

Transformers: Construction, operating principle, emf equation and turns ratio. Types of transformer, phasor diagrams for no load operation.

Module 4: (10 Hours)

DC Machines: Principle of Operation of generator and motor, EMF equation, Torque Equation, methods of excitation. Speed equation of d.c. motor, speed control of d.c. shunt motor.

Induction motor: construction of AC inductor machines, Revolving magnetic flux, torque and slip, synchronous speed.

Power Systems: Brief idea about various generating plants (Thermal, Hydel, and Nuclear), Transmission and Distribution of Electric Energy.

Text Books:

1. Electrical & Electronic Technology, E. Huges, Pearson, 9th Edition.
2. Electrical Engineering Fundamentals, Vincent Del Toro, 2nd Edition, PHI.

Reference Books:

1. C. L. Wadhwa, "Electrical Engineering", New Age International Publishers, 2nd Edition.
2. Basic Electrical Engineering, A. Fitzgerald, D. E. Higginbotham and A. Grabel, TMH, 5th Ed.

Workshop/Basic Manufacturing Practices (1-0-4) Code - UESME104

Module 1: (05 Hours)

Engineering materials: Classification of Engineering materials. Mechanical properties of Steel, Aluminum and Plastics.

Safety precautions in workshop.

Fitting: Knowledge of hand tools: V-block, Marking Gauge, Files, Hack Saw, Drills, Taps, Types of fitting.

Module 2: (05 Hours)

Welding: Study of electric arc welding tools & equipments, Models: Butt Joint, Lap Joint, T joint & L-joint.

Machining: Introduction to different machine tools: Lathe machine, Shaper machine and milling machine.

Brief introduction to other basic manufacturing processes like foundry, sheet metal operation and forming processes.

Text Books:

1. Elements of Workshop Technology, Vol. I and II by Hajrachoudhary, Khanna Publishers.

2. Workshop Technology by W. A. J. Chapman, Viva Books.
3. Workshop Manual by Kannaiah/ Narayana, Scitech.

Physics Lab (0-0-3)

Code - ULCPH101

List of Experiments

(At least 10 experiments should be done)

Experiment List:

1. Determination of Young's modulus by Searle's method / Bending of beams.
2. Determination of Rigidity modulus by static method.
3. Determination of surface tension by capillary rise method.
4. Determination of acceleration due to gravity by Bar / Kater's pendulum.
5. Verification of laws of vibration of string using sonometer.
6. Determination of wavelength of light by Newton's ring apparatus.
7. Determination of grating element of a diffraction grating.
8. Determination of wavelength of laser source by diffraction rating method.
9. Determination of wavelength using Michelson Interferometer.
10. Plotting of characteristic curve of a PN junction diode.
11. Plotting of characteristic curves of BJT.
12. Determination of unknown resistance using Meter Bridge.
13. Determine of reduction factor of the given tangent galvanometer.
14. Determination of horizontal component of earth's magnetic field by using tangent galvanometer.
15. Determination of Hall coefficient using Hall apparatus.

Basic Electrical Engineering Lab (0-0-2)

Code- ULCEE102

List of Experiments

(At least 10 experiments should be done)

Course Outcomes

At the end of the course the students are able to:

1. Learn about the working of different measuring instruments for measuring power, power factor, energy etc.
2. Verify different Network Theorems
3. Draw the Open Circuit Characteristics of dc generator and Transformer
4. Visualize the constructional details of different machines

Experiment List:

1. Basic safety precautions. Introduction and use of measuring instruments - voltmeter, ammeter, wattmeter, Rheostat, multi-meter, oscilloscope.
2. Connection and measurement of power consumption of an Incandescent, fluorescent, LED and CFL lamp and determination of power factor.
3. Power and power factor measurements in three phase system by two wattmeter method.
4. Verification of super position, Thevenin and Norton's theorem.
5. Plotting of B-H curve of different magnetic material and calculation of hysteresis loss.
6. Testing of a single-phase energy meter at different power factor.
7. Calculation of power and power factor in series R-L-C circuit excited by single-phase AC supply and draw the phasor diagram.
8. Determination of open circuit characteristics (OCC) of DC shunt generator.
9. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage.
10. Observation of the no-load current waveform of a transformer on an oscilloscope and measurement of primary and secondary voltages and currents, and power at different load.
11. Demonstration of cut-out sections of machines: dc machine (commutator- brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winding - slip ring arrangement).

Semester II (First year)

| Sl. No. | Category | Course Code | Course Title | Hours per Week | | | Credits |
|----------------------|------------------------------|-------------|-------------------------------------|----------------|---|---|-------------|
| | | | | L | T | P | |
| 1 | Basic Science Course | UBSCH201 | Chemistry | 3 | 1 | 0 | 4 |
| 2 | Basic Science Course | UBSMH202 | Mathematics-II | 3 | 1 | 0 | 4 |
| 3 | Engineering Science Course | UESCS203 | Programming for Problem Solving | 3 | 0 | 0 | 3 |
| 4 | Engineering Science Course | UESME204 | Engineering Graphics and Design | 1 | 0 | 0 | 1 |
| 5 | Humanities & Social Sciences | UHSMH205 | English | 2 | 0 | 0 | 2 |
| 6 | Basic Science Course | ULCCH201 | Chemistry Lab | 0 | 0 | 3 | 1.5 |
| 7 | Engineering Science Course | ULCCS202 | Programming for Problem Solving Lab | 0 | 0 | 4 | 2 |
| 8 | Engineering Science Course | ULCME203 | Engineering Graphics and Design Lab | 0 | 0 | 4 | 2 |
| 9 | HS | ULCMH204 | English Lab | 0 | 0 | 2 | 1 |
| Total Credits | | | | | | | 20.5 |

Course Outcomes

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

1. Understand the basics of molecular interactions.
2. Idea about organometallic and their catalytic applications.
3. Understand basics of fuels and corrosion chemistry.

Module 1: (10 Hours)

Quantum Chemistry and Spectroscopy: Basic concepts and postulates of quantum mechanics. Introduction to Schrodinger Wave Equation, Particle in a box: Energy levels, quantum numbers and selection rule.

Spectroscopy: Lambert Beer's Law, Principles and applications of UV-Visible Molecular Absorption Spectroscopy; Chromophores, applications to colorimetry. Effect of conjugation on chromophores, Absorption by aromatic systems, introductory idea on Rotational and Vibrational Spectroscopy Principles and application to diatomic molecules.

The phase rule: Statement of Gibb's phase rule and explanation of the terms involved, Phase diagram of one component system - water and sulfur system, Condensed phase rule, Phase diagram of two component system - Eutectic Bi-Cd system.

Module 2: (10 Hours)

Organometallics: Introduction to organometallics, EAN rule; classification, nomenclature and characteristics of organometallic compounds. Applications of organometallic compounds and catalyst in alkene isomerization hydrogenation and hydroformylation (detail mechanisms are to be excluded).

Module 3: (10 Hours)

Fuels: Classification of fuels, calorific value. (Determination by Dulong's formula), G. C. V. and N. C. V. Liquid fuels: Classification of petroleum, refining of petroleum, Cracking, Knocking and anti-knocking, cetane and octane numbers. Unleaded petrol, synthetic petrol, power alcohol. Gaseous Fuel: Producer gas, Water gas, LPG, CNG, Kerosene gas, Combustion calculation.

Module 4: (10 Hours)

Corrosion: Electrochemical theory of corrosion, galvanic series, Types of corrosion; Differential metal corrosion, Differential aeration corrosion (Pitting and water line corrosion), Stress corrosion (caustic embrittlement in boilers), Factors affecting, Metal coatings - Galvanizing and Timing, Corrosion inhibitors, cathodic protection.

Text Books:

1. Text Book in Applied Chemistry by A. N. Acharya and B. Samantaray, Pearson India.

2. Introductory to Quantum Chemistry by A. K. Chandra, 4th Edition, McGraw Hill Education.
3. Fundamentals of Molecular & Spectroscopy by Banwell, Tata McGraw Hill Education.
4. Physical Chemistry by Gordon M. Barrow, McGraw-Hill
5. Engineering Chemistry, 12th Edition, Author: Wiley India Editorial Team Publishers Wiley.
6. Engineering Chemistry: Fundamentals and Applications. Shikha Agarwal. Cambridge University Press.
7. Engineering Chemistry, Jain and Jain, Dhanpat Rai Publication.

Reference Books:

1. Inorganic Chemistry by Donald A. Tarr, Gary Miessler, Pearson India, Third Edition.
2. Quantum Chemistry by Ira N. Levine, Pearson 7th Edition.
3. Molecular Spectroscopy, Ira N. Levine, John Wiley and Sons
4. Modern Spectroscopy - A Molecular Approach, by Donald McQuarrie and John Simon, published by University Science Books.
5. Inorganic Chemistry by W. Overton, Rounk and Armstrong, Oxford University Press, 6th edition.

Mathematics-II (3-1-0)

Code - UBSMH202

Course Outcomes

On successful completion of this course, the students will be able to:

1. Use the basic concepts of vector and matrix algebra, including linear dependence / independence, basis and dimension of a subspace, rank and nullity for analysis of matrices and systems of linear equations,
2. Apply linear algebra techniques to solve various engineering problems,
3. Select appropriate numerical methods to apply to various types of problems in engineering and science in consideration of the mathematical operations involved, accuracy requirements, and available computational re- sources,
4. Compare different numerical methods with respect to accuracy and efficiency of the solution.

Module 1: (10 Hours)

Matrices, vectors: addition and scalar multiplication, matrix multiplication: Linear systems of equations, linear independence, rank of a matrix, determinants, Cramer's rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.

Vector space, linear dependence of vectors, basis, dimension.

Module 2: (10 Hours)

Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank-nullity theorem, composition of linear maps, matrix associated with a linear map.

Eigenvalues, eigenvectors, symmetric, skew-symmetric and orthogonal matrices, Eigen basis, Diagonalization, Inner product spaces, Gram-Schmidt orthogonalization.

Module 3: (10 Hours)

Solution of polynomial and transcendental equations - Bisection method, Newton- Raphson methods and Regula-Falsi method.

Finite differences, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference and Lagrange's formulae, Numerical approximation of functions.

Module 4: (10 Hours)

Numerical differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules, Gauss Legendre and Gauss quadrature rule.

Gauss Siedel iteration method for solving a system of linear equations Euler and modified Euler's methods, Runge-Kutta methods.

Text Books:

1. Advanced Engineering Mathematics by E. Kreyszig, John Willey & Sons Inc. 10th Edition
2. Linear algebra and its applications by Gilbert Strang, Cengage learning.

Reference Books:

1. Higher Engineering Mathematics by B. V. Ramana, McGraw Hill Education.
2. Engineering Mathematics by Pal and S. Bhunia, Oxford Publication.
3. Advance Engineering Mathematics by P. V. O'Neil.
4. Introductory methods of numerical analysis by S. S. Sastry, PHI.

Programming for Problem Solving (3-0-0) Code - UESCS203

Module 1: (10 Hours)

Introduction to Programming, Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/ Pseudo code with examples, From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code, Arithmetic expressions and precedence

Module 2: (07 Hours)

Conditional Branching and Loops, Arrays (1-D, 2-D), Character arrays and Strings, Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference, Recursion, as a different way of solving problems.

Module 3: (07 Hours)

Structure & Unions, defining structures and Array of Structures, Pointers, Idea of pointers, Defining pointers, Pointers to functions, Double pointers.

Module 4: (06 Hours)

Dynamic memory allocation, use of malloc(), calloc(), realloc(), free(). Storage classes: local, global, static & register variables. File handling: reading & writing to a file.

Text Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw Hill.
2. E. Balaguruswamy, Programming in ASI C, Tata McGraw Hill.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Engineering Graphics and Design (0-0-4) Code - UESME204

Module 1: (05 Hours)

Introduction: Introduction to Engineering Drawing, Drawing Instruments and their uses, Dimensioning, Scale, types of lines, Lettering. (1 sheet)

Orthographic Projection: Introduction to Projection, Projection types or methods (First angle and Third angle)

Plane of Projection, Reference line, orthographic Projection of Points (points located in all four quadrants), Projection of Straight lines (first and third quad- rant only), traces of lines. (1 sheet)

Orthographic Projection of Plane Surfaces in various positions (Triangle, Square, Rectangle, Rhombus, Pentagon, hexagon and Circle), Traces of a Plane. (1 sheet)

Introduction to Solids and Types of Solids, Orthographic Projection of Solids in different Positions. (1 sheet)

Module 2: (05 Hours)

Sections and Development of Lateral Surface of Solids: Sectional view (half section and full section), development of surfaces of right regular prisms, pyramids, cylinders and cones. (1 sheet)

Isometric Projection: Introduction, Isometric Scale, Isomeric projection of cube, right regular prism, cylinders and cones. (1 sheet)

Applications: Orthographic and sectional view of Machine components (Screw Thread, nut and bolt). (1 Sheet)

Auto CAD: Introduction to Auto CAD. Fundamental concepts.

Text Books:

1. Machine Drawing by N. D. Bhatt, V. M. Panchal, Charotar Publishing House.
2. Machine Drawing by N. D. Junarkar, Pearson Education.
3. Machine Drawing with AutoCAD by Goutam Pohit and Goutam Ghosh, Pearson Education.
4. Machine Drawing includes AutoCAD by Ajeet Singh, Tata McGraw Hill.

English (2-0-0)

Code - UHSMH205

Course Outcomes

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

1. Equipped with the theory and practice of communication.
2. Equipped with both theoretical vocabulary and basic tools which will help them develop as better communicators.
3. Select literary texts and establish how these texts contribute to the afore- mentioned objectives.

Module 1: (08 Hours)

Introduction to Communication:

Importance of Communication in English, the process of communication and factors that influence the process of communication: Sender, receiver, channel, code, topic, message, context, feedback, 'noise'. Principles of Communication. Barriers to Communication & Communication Apprehension, Verbal (Spoken and Written) and non-verbal communication, Body language and its importance in communication.

Module 2: (07 Hours)

Phonetics and Functional Grammar:

Sounds of English: Vowels (Monophthongs and Diphthongs), Consonants, Syllable division, stress (word, contrastive stress) & intonation, MTI and problem sounds, Review of Parts of Speech, Subject and Predicate, Tense, Voice Change, Idioms and Phrasal Verbs.

(Note: This unit should be taught in a simple, non-technical, application oriented manner, avoiding technical terms as fast as possible.)

Module 3: (05 Hours)

Reading Literature:

Prose:

- Stephen Leacock: My Financial career.
- Mahatma Gandhi: from My Experiments with Truth.
- O’Henry: The Last Leaf.

Poetry:

- Nissim Ezekiel: Professor.
- Jack Prelutsky: Be glad your nose is on your face.
- Maya Angelou: Still I rise (Abridged).

Chemistry Lab (0-0-3)

Code - ULCCH201

List of Experiments

(At least 10 experiments should be done)

Experiment List:

1. Determination of amount of sodium hydroxide and sodium carbonate in a mixture.
2. Determination of total hardness of water by EDTA method.
3. Estimation of calcium in limestone.
4. Determination of percentage of available chlorine in a sample of bleaching powder.
5. Preparation of Phenolphthalein.
6. Acid-Base Titration by Potentiometry.
7. Preparation of buffer solution and determination of pH of a buffer solution.
8. Standardization of KMnO_4 using sodium oxalate. Determination of ferrous iron in Mohr’s salt by potassium permanganate.
9. Determination of partition coefficients of iodine between benzene and water.
10. Determination of rate constant of acid catalyzed hydrolysis reaction.
11. Determination of concentration of a colored substance by spectrophotometer.
12. Determination of dissolved oxygen in a sample of water.
13. Determination of Viscosity of a lubricating oil by Red Wood viscometer.
14. Determination of Flash point of a given oil by Pensky-Marten’s flash point approach.
15. Determination of Critical Micelle concentration (CMC) of an ionic surfactant (Both cationic and anionic).

Programming for Problem Solving Lab (0-0-4) Code - ULCCS202

List of Experiments

(At least 10 experiments should be done)

Experiment List:

1. Familiarization with programming environment.
2. Simple computational problems using arithmetic expressions.
3. Problems involving if-then-else structures.
4. Iterative problems e.g., sum of series.
5. 1-D Array manipulation.
6. Matrix problems, String operations.
7. Simple functions.
8. Programming for solving Numerical methods problems (1).
9. Programming for solving Numerical methods problems (2).
10. Recursive functions.
11. Pointers and structures.
12. File operations.

English Lab (0-0-2)

Code - ULCMH204

List of Experiments

(All the experiments should be done)

Course Outcomes

At the end of the course the students are able to:

1. Acquainted with their strength and weakness in expressing themselves, their interests and academic habits.
2. Improve skills of LSRW (Listening, Speaking, Reading and Writing) through mutual conversation and activities related to these skills.
3. Promote the creative and imaginative practices before the teacher-trainer.

Lab sessions will give a platform for the students to indulge in activities based on the first two modules of theory taught in the class room. All the lab classes will be divided in such a manner that all the four aspects of language (LSRW) are covered.

Experiment List:

1. Speaking: Ice-breaking and Introducing each other, Writing: Happiest and saddest moment of my life.
2. Listening: Listening practice (ear training): News clips, Movie clips, Presentation, Lecture or speech by a speaker, Speaking: Debate.
3. Reading: Reading comprehension, Writing: Creative writing (Short story: Hints to be given by teacher).
4. Reading: Topics of General awareness, Common errors in English usage, Writing: Construction of different types of sentences.
5. Speaking: Practice of vowel and consonant sounds, Writing: Practice of syllable division.
6. Speaking: My experience in the college/ or any other topic as per the convenience of the student, Writing: Phonemic transcription practice.
7. Listening: Practice of phonetics through ISIL system and also with the help of a dictionary, Speaking: Role-play in groups.
8. Speaking: Practice sessions on Stress and Intonation, Writing: Practice sessions on Grammar (Tense and voice change).
9. Speaking: Extempore, Writing: Framing sentences using phrasal verbs and idioms.
10. Watching a short English Movie, Writing: Critical analysis of the movie.

End-term Assignment: Students are required to make a project of at least 5 pages on a topic on the following broad streams: Technology, General awareness, Gender, Environment, Cinema, Books and the like. The assignment should involve data collection, analysis and reporting.

B. Tech. 2nd year Autonomous Syllabus

Semester III (Second year)

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|---------------------------|--------------|---|---------------------|---|---|-----------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Core Course | UPCEE301 | Electrical Circuit Analysis | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course | UPCIE302 | Analog Electronic Circuit | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Core Course | UPCEE302 | Electrical Machines-I | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 4 | Engg. Science Course | UPCEE303 | Electromagnetic Fields | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Basic Science Course | UBSMH301 | Mathematics-III | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 6 | Humanities Science Course | UHSMH302 | Organizational Behaviour/ Engineering Economics | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 7 | Lab Course | ULCEE301 | Analog Electronic Circuit Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCEE302 | Electrical Machines-I Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 23 | | | | 800 |

Electrical Circuit Analysis (3-0-0)

Code - UPCEE301

Prerequisites

1. Basic Electrical Engineering.

Course Outcomes

At the end of this course, students will demonstrate the ability to

1. Apply network theorems for the analysis of electrical circuits.
2. Obtain the transient and steady-state response of electrical circuits.
3. Analyze circuits in the sinusoidal steady-state.
4. Analyze two port circuit behaviour.

Module 1: (10 Hours)

Network Theorems: Node and Mesh Analysis, Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem (All theorems with AC excitation). Analysis with dependent current and voltage sources. Concept of duality and dual networks. series and parallel resonances

Coupled circuit: Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

Module 2: (10 Hours)

Laplace Transform: Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, inverse Laplace transform, transformed network with initial conditions

Transient: Solution of first and second order differential equations for Series and parallel R-L, R-C, RLC circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Two Port Networks: Z, Y, ABCD and h-parameters, Reciprocity and Symmetry, Interrelation of two-port parameters, Interconnection of two-port networks

Module 3: (07 Hours)

Network function: Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), Restriction on location of Poles and Zeros, Time domain behaviour from Pole- Zero plots.

Network synthesis: Hurwitz polynomial, Positive real functions, Concepts of network synthesis, Realization of simple R-L, R-C and L-C functions in Cauer-I, Cauer-II, Foster-I and Foster-II forms.

Module 4: (07 Hours)

Fourier Analysis: Fourier series, Fourier analysis and evaluation of coefficients, Steady state response of network to complex periodic signals, Fourier transform and convergence, Fourier transform of some functions

Filter: Brief idea about network filters (Low pass, High pass, Band pass and Band elimination) and their frequency response.

Text Books:

1. Network Analysis, M. E. Van Valkenburg, PHI, third edition.
2. Fundamentals of Electric Circuits, Charles K Alexander & Mathew N. O. Sadiku, Tata McGraw Hill, fifth edition.

Reference Books:

1. Network Analysis and Synthesis, Franklin F. Kuo, Wiley Student Edition.

Analog Electronics Circuit (3-0-0)

Code- UPCIE302

Prerequisites

1. Network Theory.

Course Outcomes

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

1. Analyze simple electronic circuits based on transistors with special focus on designing amplifiers with discrete components.
2. Develop the skill to build, and troubleshoot Analog circuits.
3. Design higher order transistor amplifiers and oscillators.
4. Determine transfer function for frequency dependent amplifier circuits, draw bode plots (magnitude and phase) and calculate frequency band- width.
5. Design different signal conditioning circuits like differentiator, integrator and instrumentation amplifier using Op-Amp.

Module 1: (12 Hours)

Biasing of BJTs: Load lines (AC and DC); Operating Points; DC Bias with Voltage Feedback; Bias Stabilization; Examples.

MOS Field-Effect Transistor: Principle and Operation of FETs and MOS- FETs; P Channel and N-Channel MOSFET; Complimentary MOS; V-I Characteristics of EMOSFET and D-MOSFET; MOSFET as an Amplifier and as a Switch.

Biasing of FETs and MOSFETs: Fixed Bias Configuration and Self Bias Configuration, Voltage Divider Bias and Design

Module 2: (12 Hours)

Small Signal Analysis of BJTs: Small-Signal Equivalent-Circuit Models; Small Signal Analysis of CE, CC, CB amplifiers. Brief Introduction to-Emitter Follower, Cascade amplifier, Darlington Connection and Current Mirror Circuits.

Small Signal Analysis of FETs: Small-Signal Equivalent-Circuit Model, Small Signal Analysis of CS, CD, CG Amplifiers. Effects of RSIG and RL on CS Amplifier; Source Follower and Cascaded System.

High Frequency Response of FETs and BJTs: High Frequency equivalent models and frequency Response of BJTs and FETs; Frequency Response of CS Amplifier, Frequency Response of CE Amplifier.

Operational Amplifier: Ideal Op-Amp, Differential Amplifier, Op-Amp Parameters, Non-inverting Configurations, Open-loop and Closed-loop Gains, Differentiator and Integrator, Instrumentation amplifier.

Module 3: (10 Hours)

Feedback amplifier and Oscillators: Concepts of negative and positive feed- back; Four Basic Feedback Topologies, Practical Feedback Circuits, Principle of Sinusoidal Oscillator, Wein-Bridge, Phase Shift and Crystal Oscillator Circuits.

Power Amplifier: Brief Introduction to different classes of amplifier (A, B, AB, C).

Regulated DC Power Supply: Transistor series voltage regulator, series feedback voltage regulator, Transistor shunt voltage regulator, shunt feedback voltage regulator.

Text Books:

1. Electronic Devices and Circuits theory, R.L. Boylestad and L. Nashelsky, Pearson Education, New Delhi, 9th/10th Edition,2013. (Selected portions of Chapter 4, 5, 6, 7, 8, 9, 10, 11, 12, and 14)
2. Microelectronics Circuits, Adel Sedra and Kenneth C Smith, Oxford University Press, New Delhi, 5th Edition, International Student Edition,2009. (Selected portion of Chapter 2,4, 5, 6, 8, 13, and 14)
3. Design with Operational Amplifiers and Analog Integrated Circuits, Sergio Franco, McGraw Hill Education,4th Edition

Reference Books:

1. Integrated Electronics: Analog and Digital Circuits and Systems, J. Milliman, C. Halkias, Tata McGraw Hill Publishing Company Ltd., New Delhi,2nd Edition.2004.
2. Electronic device and circuits, David A. Bell, Oxford University Press, 5th edition,2008.
3. Microelectronics Circuits: Analysis and design by Mohammed H. Rashid, Cengage Learning India, 2012.
4. Electronics Principles, A P Malvino, David J Bates, McGraw Hill Education, 7th Edition

Prerequisites

1. Basic Electrical Engineering.

Course Outcomes

At the end of this course, students will demonstrate the ability to

1. Understand the operation of dc machines.
2. Analyze the differences in operation of different dc machine configurations.
3. Analyze single phase and three phase transformers circuits.

Module 1: (12 Hours)

DC Generators: Principle of operation, constructional features, magnetic structure, Action of commutator, Armature windings- simplex lap and wave windings, E.M.F. Equation, Methods of Excitation, Armature reaction, Effect of brush shift, Cross magnetizing and demagnetizing AT/pole, interpole, compensating winding, Effect of armature reaction on air gap flux density distribution, commutation, methods of improving commutation. Open circuit characteristics, critical field resistance and critical speed, voltage build up, external and internal characteristics of shunt, series and compound generators. Applications.

Module 2: (12 Hours)

DC Motor: Principle of operation, Back E.M.F., Torque equation, characteristics and application of shunt, series and compound motors, Starting of DC motor, Principle of operation of 3 point and 4 point starters. Speed control of DC Motors: Armature voltage and field flux control methods, Ward Leonard method. Losses and efficiency. Methods of Testing: direct, indirect and regenerative testing, brake test, Swinburne's test, Hopkinson's test.

Module 3: (08 Hours)

Single phase Transformers: Constructional details, principle of operation, magnetizing current, emf equation, Phasor diagram, equivalent circuit, losses and efficiency, voltage regulation, open circuit and short circuit tests, polarity test, Sumpner's test, separation of hysteresis and eddy current losses. All day efficiency.

Autotransformers: Construction, principle, conversion of two winding transformer to single winding transformer, applications and comparison with two winding transformer.

Module 4: (08 Hours)

Three phase Transformers: Constructional features, as a single unit and as a bank of three single phase transformers, types of connection and their comparative features, Phasor groups (Dd0, Dd6, Yy0, Yy6, Dy1, Dy11, Yd1, Yd11, zigzag), Scott connection, open delta connection, three phase to six phase connection, oscillating neutral, tertiary winding, three winding transformer. Parallel operation, load sharing.

References Books:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.

2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.
7. Stephen J. Chapman- "Electric Machinery and Fundamentals" - McGraw Hill International Edition, (Fourth Edition), 2005.

Electromagnetic Fields (3-0-0)

Code - UPCEE303

Prerequisites:

1. Mathematics-I
2. Mathematics-II

Course Outcomes

At the end of the course, students will demonstrate the ability

1. To understand the basic laws of electromagnetism.
2. To obtain the electric and magnetic fields for simple configurations under static conditions.
3. To analyze time varying electric and magnetic fields.
4. To understand Maxwell's equation in different forms and different media.
5. To understand the propagation of EM waves.

Module 1: (08 Hours)

Co-ordinate systems & Transformation: Cartesian co-ordinates, circular cylindrical co-ordinates, spherical co-ordinates. Vector Calculus: Differential length, Area & volume, Line, surface and volume Integrals, Del operator, Gradient of a scalar, Divergence of a vector & Divergence theorem, Curl of a vector & Stoke's theorem, Laplacian of a scalar.

Module 2: (10 Hours)

Electrostatic Fields: Coulomb's Law, Electric Field Intensity, Electric Fields due to point, line, surface and volume charge, Electric Flux Density, Gauss's Law- Maxwell's Equation, Applications of Gauss's Law, Electric Potential, Relationship between E and V- Maxwell's Equation an Electric Dipole & Flux Lines, Energy Density in Electrostatic Fields., Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions. Electro- static boundary-value problems: Poisson's and Laplace's Equations, Uniqueness Theorem, General procedures for solving Poisson's and Laplace's equations, Capacitance

Module 3: (06 Hours)

Magnetostatic Fields: Magnetic Field Intensity, Biot-Savart's Law, Ampere's circuit Law-Maxwell Equation, applications of Ampere's law, Magnetic Flux Density-Maxwell's equations. Maxwell's equation for static fields, Magnetic Scalar and Vector potentials. Magnetic Boundary Conditions

Module 4: (10 Hours)

Electromagnetic Field and Wave propagation: Faraday's Law, Trans- former & Motional Electromagnetic Forces, Displacement Current, Maxwell's Equation in Final forms, Time-Harmonic Field. Electromagnetic Wave Propagation: Wave Propagation in lossy Dielectrics, Plane Waves in loss less Di- electrics, Free space, Good conductors Power & Poynting vector.

Text Books:

1. Matthew N. O. Sadiku, Principles of Electromagnetics, 6th Ed., Oxford Intl. Student Edition, 2014.

Reference Books:

1. C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, 3rd Ed, TMH.
2. W.H. Hyat, Electromagnetic Field Theory, 7th Ed, TMH.
3. A. Pramanik," Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
4. A. Pramanik," Electromagnetism-Problems with solution", Prentice Hall India, 2012.
5. G.W. Carter," The electromagnetic field in its engineering aspects", Long- mans, 1954.
6. W.J. Duffin," Electricity and Magnetism", McGraw Hill Publication, 1980.
7. W.J. Duffin," Advanced Electricity and Magnetism", McGraw Hill, 1968.
8. E.G. Cullwick," The Fundamentals of Electromagnetism", Cambridge University Press, 1966.
9. B. D. Popovic," Introductory Engineering Electromagnetics", Addison- Wesley Educational Publishers, International Edition, 1971.
10. W. Hayt," Engineering Electromagnetics", McGraw Hill Education, 2012.

Mathematics-III (3-1-0)

Code - UBSMH301

Prerequisites:

1. Mathematics-I
2. Mathematics-II

Course Outcomes

On successful completion of this course, the students will be able to:

1. Have a fundamental knowledge of the concepts of probability theory.

2. Do correlation and regression and fitting of different types of curves.
3. Apply sampling theory and theory of estimation in various engineering problems and do various tests of hypothesis and significance.
4. Use calculators and tables to perform simple statistical analyses for small samples and use popular statistics packages, such as SAS, SPSS, S-Plus, R or MATLAB to perform simple and sophisticated analyses for large samples.

Module 1: (10 Hours)

Probability: Introduction, Probability of an event, additive rule & multiplication rule, conditional probability, Bayes' rule, random variable, discrete and continuous probability distribution, Joint probability distribution, Mathematical expectations, Variance and Co- variance of random variables, Mean and Co- variance of linear combination of random variables, Chebyshev theorem.

Module 2: (10 Hours)

Discrete Probability Distribution: Binomial & Multinomial, Hyper- geo- metric, Geometric, Poisson distribution.

Continuous Probability Distribution: Uniform, Normal, Exponential Distribution, Weibull's Distribution, Chi-square Distribution, Sampling Distribution: Sampling Distribution of S^2 , t Distribution, F Distribution.

Module 3: (10 Hours)

Estimation of parameter: methods of estimation, Estimating the mean of a single sample, Standard error, Prediction interval, Tolerance limits, Estimating the difference between means of two samples, estimating proportion and variance of single sample, Estimating the difference between two proportions and variances of two samples, maximum likelihood estimation.

Module 4: (10 Hours)

Testing of hypothesis: one and two tailed test, test on a single mean when variance is known & variance is unknown. Test on two means, test on single mean and two mean populations. One and two sample test for variance. χ^2 test for goodness of fit and test for independence.

Introduction to linear regression: Simple regression models, method of least squares, Properties of least square estimators, Inferences concerning the regression coefficients, Coefficients of determination and its application.

Statistical quality control (Simple Idea only)

Text Books:

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers & Keying Ye," Probability & Statistics for Engineers & Scientists", Eighth Edition, 2007, Pearson Education Inc., New Delhi.
2. Jay L. Devore," Probability and Statistics for Engineering and Sciences", Seventh Edition, Thomson/CENGAGE Learning India Pvt. Ltd.

Reference Books:

1. William Mendenhall, Robert J. Beaver & Barbara M. Beaver, "Introduction to Probability and Statistics", 13th Edition, 2009, CENGAGE Learning India Pvt. Ltd., New Delhi.
2. T. Veerarajan, "Probability, Statistics and Random Processes", Tata McGraw Hill
3. Ronald Deep, "Probability and Statistics", Academic Press

Engineering Economics (3-0-0) Code -UHSMH302

Prerequisites:

1. Mathematics.
2. Basic Economics.

Module 1: (10 Hours)

Engineering Economics: Nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics.

Demand: Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Demand Estimation and Forecasting, Elasticity of demand & its measurement (Simple numerical problems to be solved), Supply-Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).

Production: Production function, Laws of returns: Law of variable proportion, Law of returns to scale.

Module 2: (10 Hours)

Cost and revenue concepts, Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Banking: Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank.

Inflation: Meaning of inflation, types, causes, measures to control inflation.

National Income: Definition, Concepts of national income, Method of measuring national income.

Module 3: (10 Hours)

Time value of money: Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.

Evaluation of engineering projects: Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.

Depreciation: Depreciation of capital asset, causes of depreciation, Methods of calculating depreciation (Straight line method, Declining balance method), After tax comparison of project.

Text Books:

1. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India.
2. Deviga Vengedasalam, "Principles of Economics", Oxford University Press.
3. William G. Sullivan, Elin M. Wicks, C. Patric Koelling, "Engineering Economy", Pearson.
4. R. Paneer Selvam, "Engineering Economics", PHI.
5. S. P. Gupta, "Macro Economics", TMH.
6. S. B. Gupta, "Monetary Economics", Sultan Chand and Co.

Analog Electronics Lab (0-0-3) Code - ULCEE301

List of Experiments

(At least 10 experiments should be done)

Course Outcomes

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

1. Acquire a basic knowledge in solid state electronics including FET, MOS- FET, BJT, and operational amplifier.
2. Designing and evaluation of BJT amplifier in CE configuration.
3. Design and test JFET/MOSFET amplifier.
4. Evaluate possible causes of discrepancy in practical experimental observations in comparison to theory.

Experiment List:

1. Usage of different electronics components (active and passive) and devices and Diode Characteristics.
2. Input output characteristic of BJT in common emitter configuration.
3. Design and simulate BJT voltage divider bias (CE) circuit and compare the results.
4. Design and test MOSFET bias circuit and compare the results.
5. Design and test BJT common-emitter circuit and compare D.C and A.C performance.
6. Transfer and drain characteristic of MOSFET.
7. Determining the frequency response of a common-emitter amplifier: low frequency, high frequency and mid frequency response and compare with simulated results.
8. Differential amplifiers circuits: D.C bias and A.C operation without and with current source.
9. Realize BJT Darlington connection and Current Mirror circuits.
10. Frequency response of a voltage series feedback amplifier with and without feedback.

11. Applications of OPAMP-Inverting and non-inverting, differentiator, integrator
12. Obtain the band width of FET/ BJT using Square wave testing of an amplifier.
13. R.C phase shift oscillator/ Wien-Bridge Oscillator using OP-Amp/ Crystal Oscillator.
14. Class A and Class B Power Amplifier.
15. Software based (SPICE) simulation of a few of the experiments (1-14).

Electrical Machines-I Lab (0-0-3)

Code - ULCEE302

List of Experiments

(At least 10 experiments should be done)

Course Outcomes

At the end of the course the students are able to:

1. Connect both single phase and three phase transformers in various ways as per the requirement.
2. Determine the equivalent circuit parameters and estimate voltage regulation and efficiency from it for transformer.
3. Start, control the speed and determine the efficiency of different types of DC Motors in various ways.
4. Determine the parameters and performance characteristics of DC Generators.

Experiment List:

1. Determination of critical resistance and critical speed from no load test of a DC shunt generator.
2. Plotting of external and internal characteristics of a DC shunt generator.
3. Speed control of DC shunt motor by armature voltage control and flux control method.
4. Determination of efficiency of DC machine by Swinburne's Test and Brake Test.
5. Determination of efficiency of DC machine by Hopkinson's Test.
6. Determination of efficiency and Voltage Regulation by Open Circuit and Short Circuit test on single phase transformer.
7. Polarity test and Parallel operation of two single phase transformers.
8. Back-to Back test on two single phase transformers.
9. Study of open delta and Scott connection of two single phase transformers.
10. Study of different three phase transformer connections (star-star, star delta etc.).
11. Separation of core losses in a single phase transformer.

Semester IV (Second year)

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|--|----------------|---|---------------------|---|---|-------------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Core Course | UPCEE401 (I&E) | Digital System Design | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course | UPCEE402 | Electrical Machine-II | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 3 | Core Course | UPCEE403 | Measurement Techniques | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Engg. Science Course | UPCEE404 (I&E) | Signal and Systems | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Humanities Science Course | UHSMH402 | Organizational Behavior | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Lab Course | ULCEE401 (I&E) | Digital System Design Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 7 | Lab Course | ULCEE402 | Electrical Machine-II Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCEE403 | Measurement Techniques Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 9 | Mandatory Course | | Environmental Science/ Constitution of India | | | | 0 | 30 | 70 | 0 | 100 |
| | | | Total | | | | 20.5 | | | | 900 |
| 10 | Summer Internship programme (4 to 8 weeks) is mandatory as per AICTE rule | | | | | | | | | | |

Digital System Design (3-0-0)

Prerequisites:

1. Basic concepts of number system
2. Basic knowledge of electronic circuits

Course Outcomes

At the end of the course, a student will be able to:

1. Convert different type of codes and number systems which are used in digital communication and Computer systems and Employ the codes and number systems converting circuits and Compare different types of logic families.
2. Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods.
3. Design different types of digital electronic circuits (with and without memory element) for particular operation, within the realm of economic, performance, efficiency, user friendly and environmental constraints.
4. Design & analyze synchronous sequential logic circuits
5. Use HDL & appropriate EDA tools for digital logic design and simulation

Module 1: (12 Hours)

Introduction to Digital Circuits: Representation of numbers in binary, octal, decimal and hexadecimal systems. Conversion between systems, 1's and 2's complement representation of numbers.

Logic Gates and Combinational Circuits: Functions, representations and truth tables of logic gates. Universal logic gates, Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps, Binary codes, Code Conversion.

MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU.

Module 2: (10 Hours)

Multivibrator: Bistable Multivibrator, fixed-bias bistable multivibrator, self-biased transistor binary, Schmitt Trigger Circuit, Monostable Multivibrator, Gate Width of a Collector-Coupled Monostable Multivibrator, Waveforms of the Collector-Coupled Monostable Multivibrator, Triggering of the Monostable Multivibrator. Collector Coupled Astable Multivibrator.

Module 3: (12 Hours)

Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation.

Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using Programmable Devices.

Text Books:

1. Morris Mano and Michael D. Ciletti, "Digital Design", 4th Ed., Pearson Education, 2008.
2. C.H. Roth, "Fundamentals of Logic Design", 5th Ed. Cengage Learning, 2004.
3. Digital Design-Principles and Practices, John F. Wakerly, Pearson Publication, 4th Edition
4. A Anand Kumar, "Fundamentals of Digital Circuits", 2nd Ed., PHI

Reference Books:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.
2. Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.
3. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd edition, 2006.
4. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989

Electrical Machines- II (3-1-0)

Code - UPCEE402

Prerequisites:

1. Basic Electrical Engineering.
2. Electrical Machines

Course Outcomes

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of rotating magnetic fields.
2. Understand the operation of ac machines.
3. Analyze performance characteristics of ac machines.

Module 1: (12 Hours)

Fundamentals of AC machine windings: Fundamental Principles of rotating Machines, relation between speed & frequency. Full pitch & short pitch windings, distributed winding, winding factors. Air-gap MMF distribution. Physical arrangement of windings in stator and cylindrical rotor. Concept of revolving magnetic field.

Module 2: (12 Hours)

Synchronous Generator: Constructional features, E.M.F. equation, Effect of harmonics on star and delta connection. Armature reaction, equivalent circuit, phasor diagram, open circuit & short circuit

characteristics, synchronous reactance, SCR, zpf characteristics, Potier reactance, voltage regulation by EMF method and ZPF method. Expression of active and reactive power, power angle characteristics.

Blondel's two reaction theory, phasor diagram, calculation of excitation voltage and load angle, Power and power angle characteristics, Slip Test.

Parallel operation: Synchronizing method, load sharing between alternators in parallel. Synchronizing power and torque.

Synchronous Motor: General Physical consideration, torque and power relations, V & inverted V-curves, Effect of change of excitation, synchronous condenser, starting of Synchronous Motor, performance characteristics of synchronous motor. Hunting.

Module 3: (08 Hours)

Three Phase Induction Motors: Types, Construction and principle of operation, equivalent circuit, phasor diagram, power and torque expression, Torque Slip Characteristics, Effect of variation of rotor resistances and stator voltage on torque speed characteristics. Stable & unstable region of operation, no load and Blocked rotor test, Operation with unbalanced supply voltage. Losses and Efficiency. Starting and speed control of 3 phase induction motors. Cogging and Crawling of Induction motor, breaking, 3-phase induction generator concepts and application in Wind Energy Conversion Systems.

Module 4: (08 Hours)

Single-phase induction motors: Single phase induction motor, theory of operation, Double revolving field theory, equivalent circuit, Determination of parameters, Methods of starting: split phase starting, Repulsion starting, shaded pole starting, performance characteristics. Universal motor. Stepper motor.

Reference Books:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.
7. Stephen J. Chapman, "Electric Machinery and Fundamentals" - McGraw Hill International Edition, (Fourth Edition), 2005.

Measurement Techniques (3-0-0)

Code - UPCEE403

Prerequisites:

1. Electrical Circuit Analysis.

Course Outcomes

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

1. Select type of meter and extend the range of measurement in deflecting type instruments (Ammeter & Voltmeter). Choose and Design Electronics Voltmeter for measurement of Average Value, RMS Value and Peak Value. Calibrate these instruments for measurement.
2. Analyze the methods of electrical power and energy measurement. Calculate error, estimate correction factor, develop static and smart meters and calibrate the instrument.
3. Understand the need of instrument transformers and their industrial applications.
4. Evaluate measurement range and select type of instrument required for the measurement of Resistance (Low, Medium and High), Inductance (Low & High) and Capacitance (low & High). Identify and choose components regard to quality factor and dissipation factor.
5. Apply the usefulness of Oscilloscope for measurement of Voltage, Current, Power, Phase Angle, Time Period and frequency and explore Lissajous patterns.
6. Analyze the working of transducers for physical parameters measurement in order to fulfill the desired requirement.

Module 1: (10 Hours)

Types of measuring instruments: Measurement and Error: Definition, Accuracy and Precision, Significant Figures, Drift, Hysteresis, Types of Errors.

Ammeter and Voltmeter: Derivation for Deflecting Torque of PMMC, MI (attraction and repulsion types) and Electro Dynamometer Type Ammeters and Voltmeters.

Energy meter and wattmeter: Construction, Theory and Principle of operation of Electro-Dynamometer type wattmeter (compensation, creep, error, testing), Single Phase and three phase Induction Type Energy meters, Tariff meters and specification, Introduction to Smart meters and prepaid meters, automatic meter reading (AMR), Meter Testing, DLMS protocol.

Module 2: (10 Hours)

Measurement of Resistance, Inductance and Capacitance: Resistance: Measurement of Low Resistance by Kelvin's Double Bridge, Measurement of Medium Resistance, Measurement of High Resistance, Meggers, Mega ohm meters, 5 and 10 kV portable meters, Polarization Index.

Inductance: Measurement of self Inductance using AC Bridges (Maxwell's, Hay's, & Anderson Bridge), Measurement of Mutual Inductance by Felici's Method, and as Self Inductance.

Capacitance: Measurement of Capacitance using AC Bridges (Schering, De Sauty's Bridge), Wagnor Earthing Device, Tan Delta measurement.

Current Transformer and Potential Transformer: Construction, Theory, Characteristics and Testing of CTs and PTs.

Module 3: (10 Hours)

Electronic Instruments for Measuring Basic Parameters: Ammeter and Voltmeter: Amplified DC Meters, AC Voltmeters using Rectifiers, True RMS Voltmeter, Digital Voltmeters (Block Diagrams only), Q meters, Digital Multi-meter.

Oscilloscope: Principles and Working of Analog and Digital Storage Oscilloscopes, Introduction to phasor measurement(PMU), Principle of Harmonic measurement, analyzer.

Measurement of physical parameters: Flicker meter, optical CT, Fault Locator, Thermovision camera, Partial discharge measurement, Measurement of irradiance, Land dB noise level, Introduction to Transducers, sensors and MEMS.

Text Books:

1. Electrical Measurements and Measuring Instruments- Golding & Widdis, Reem Publication.
2. Modern Electronic Instrumentation and Measurement Techniques- Helfrick & Cooper- Pearson Education.
3. Digital and Analogue Instrumentation-Testing and Measurement, Nihal Kularatna, IET Press, 2003

Reference Books:

1. Electronic Instrumentation- H C Kalsi- 2nd Edition, Tata McGraw Hill.
2. Electronic Measurement and Instrumentation- Oliver & Cage- Tata McGraw Hill.
3. A Course in Electrical and Electronic Measurements and Instrumentation- A K Sawhney- Dhanpat Rai & Co

Signals and Systems (3-0-0)

Prerequisites:

Basic knowledge of Engineering Mathematics required, which includes - Differential equations and Integrals, Laplace transform, Ordinary differential equations, Complex numbers, Series and expansions, Fourier analysis.

Course Outcomes

At the end of this course students will be able to

1. Analyze different types of signals
2. Represent continuous and discrete systems in time and frequency domain using different transforms
3. Investigate whether the system is stable
4. Sampling and reconstruction of a signal

Module 1: (12 Hours)

An introduction to signals and systems: Signals and systems as seen in everyday life, and in various branches of engineering, Continuous-Time and Discrete-Time Signals, Transformations of the Independent Variable, Exponential and Sinusoidal Signals, The Unit Impulse and Unit Step Functions, Continuous-Time and Discrete-Time Systems, Basic System Properties.

Linear Time-Invariant Systems: Continuous-Time LTI Systems: The Convolution Integral, Properties of Linear Time-Invariant Systems, Causal LTI Systems Described by Differential and Difference Equations, Singularity Functions.

Fourier analysis of Continuous Time signal and system: A Historical Perspective, The Response of LTI Systems to Complex Exponentials, Fourier Series Representation of Continuous-Time Periodic Signals, Convergence of the Fourier Series, Properties of Continuous-Time Fourier Series, Fourier Series and LTI Systems, Filtering, Examples of Continuous-Time Filters Described by Differential Equations.

Module 2: (10 Hours)

The Continuous-Time Fourier Transform: Representation of Aperiodic Signals: The Continuous-Time Fourier Transform, The Fourier Transform for Periodic Signals, Properties of the Continuous-Time Fourier Transform, The Convolution Property, The Multiplication Property, Fourier Properties and Basic Fourier Transform Pairs, Systems Characterized by Linear Constant- Coefficient Differential Equations.

Time- and Frequency Characterization of Signals and Systems: The Magnitude-Phase Representation of the Fourier Transform, The 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, First-Order and Second-Order Continuous- Time Systems.

Module 3: (10 Hours)

The Laplace Transform: The Laplace Transform for continuous time signals and systems: the notion of Eigen functions of LSI systems, a basis of Eigen functions, region of convergence, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. Generalization of Parseval's Theorem.

Sampling: Representation of a Continuous-Time Signal by Its Samples: The Sampling Theorem, Reconstruction of a Signal from Its Samples Using Interpolation, The Effect of Under sampling: Aliasing, Anti-aliasing Filters, Discrete- Time Processing of Continuous-Time Signals.

Text Books:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2. A NagoorKani, Signals & Systems, 2nd Edition, McGraw Hill. 2017
3. Schaum's outlines, Signal and System, H. P. Hsu, 2nd Edition

Reference Books:

1. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall.
2. Douglas K. Lindner, "Introduction to Signals and Systems", McGraw Hill International Edition.

3. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited.
4. M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", Tata McGraw Hill Edition.

Organizational Behaviour (3-0-0)

Code- UHSMH402

Prerequisites:

1. English.

Module 1: (10 Hours)

The study of Organizational Behaviour: Definition, Meaning, Why study OB; Learning - Principles of learning and learning theories; Personality- Meaning, Determinants, Types, Personality and OB; Perception- Perceptual Process, perceptual errors, Importance of perception in organizations; Motivation- Nature and Importance, Theories of motivation (Herzberg, Maslow, McGregor).

Module 2: (10 Hours)

Group level: Groups in Organizations -Nature, Types, Reasons behind forming groups, Determinants, factors contributing to Group Cohesiveness, Group Decision Making- Process, advantages and disadvantages; Team- Effective Team Building; Types of Leadership- Effective Leadership, Styles of leadership, Leadership Theories-Trait Theory and Contingency Theory, Leadership and Followership; Conflict- Healthy Vs Unhealthy conflict, Conflict Resolution Techniques.

Module 3: (10 Hours)

Structural level: Organizational Culture: culture and organizational effectiveness; Organizational Change: Types of change, Reasons to change, Resistance to change and to manage resistance. Introduction to organizational development.

Text Books:

1. Stephens P. Robbins, Organizational Behaviour, PHI.
2. K. Aswathappa, Organizational Behaviour, HPH.

Reference Books:

1. Kavita Singh, Organizational Behaviour, Pearson.
2. D. K. Bhattacharya, Organizational Behaviour, OUP.
3. Pradeep Khandelwal, Organizational Behaviour, TMH.
4. Keith Davis, Organizational Behaviour, McGraw Hill.
5. Nelson Quick, ORGB, Cengage Learning.

Digital System Design Lab (0-0-3)

List of Experiments

(At least 10 experiments should be done)

Course Outcomes

At the end of the course, a student will be able to:

1. Design and analyze combinational logic circuits
2. Design & analyze modular combinational circuits with MUX/DEMUX, Decoder, Encoder
3. Design & analyze synchronous sequential logic circuits
4. Use HDL & appropriate EDA tools for digital logic design and simulation

Experiment List:

Hardware:

1. Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, EX-NOR, Invert and Buffer gates.
2. Combinational Circuits: design, assemble and test: adders and subtractors, code converters, gray code to binary and 7 segment displays.
3. Design, implement and test a given design example with (i) NAND Gates only (ii) NOR Gates only and (iii) using minimum number of Gates.
4. Design with multiplexers and de-multiplexers.
5. Flip-Flop: assemble, test and investigate operation of SR, D & J-K flip- flops.
6. Counters: Design, assemble and test various ripple and synchronous counters - decimal counter, Binary counter with parallel load.
7. Clock-pulse generator: design, implement and test.

Software:

1. Design CMOS Inverter using Mentor Graphics/any open source software
2. Design AND, OR, NAND, NOR, EX-OR, EX-NOR gate using VHDL/ Verilog and Implement on FPGA
3. Design adders and subtractors, code converters using VHDL/ Verilog and Implement on FPGA
4. Design 4-BIT Magnitude Comparator using VHDL/ Verilog and Implement on FPGA
5. Design 8X1 Multiplexer, 1X4 Demultiplexer using VHDL/ Verilog and Implement on FPGA
6. Design ALU using VHDL/ Verilog and Implement on FPGA.

7. Design Decade Counter using VHDL/ Verilog and Implement on FPGA.

Reference Books:

1. Morris Mano and Michael D. Ciletti, "Digital Design", 4th Ed., Pearson Education, 2008.
2. Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.

Electrical Machines-II Lab (0-0-3)

Code - ULCEE402

List of Experiments

(At least 10 experiments should be done)

Course Outcomes

At the end of the course the students are able to:

1. Determine the equivalent circuit parameters and estimate voltage regulation of synchronous generator.
2. Determine different parameters of a synchronous machine.
3. Start, control the speed and determine the efficiency of an Induction Motor
4. Identify various types of 1-Phase IM and can calculate the parameters.

Experiment List:

1. Determination of the voltage regulation of an alternator by synchronous impedance method and zero power factor (zpf) method
2. Determination of the V and inverted V curves of a synchronous motor
3. Speed control of a three phase induction motor using variable frequency drives
4. Determination of parameters of synchronous machine
 - (a) Positive sequence reactance
 - (b) Negative sequence reactance
 - (c) Zero sequence reactance
5. Determination of power angle characteristics of an alternator
6. Determination of parameter of a Capacitor start single phase induction motor.
7. Study of parallel operation of two alternators
8. Measurement of direct and quadrature axis reactance of a salient pole synchronous machine by Slip test.

9. Measurement of transient and sub transient reactance of a salient pole alternator
10. Performance of grid connected induction generator.
11. Determination of parameters of three phase induction motor from No Load Test and Blocked Rotor Test.
12. Determination of Efficiency, Plotting of Torque-Slip Characteristics of Three Phase Induction motor by Brake Test.

Measurement Techniques Lab (0-0-3) Code- ULCEE403

List of Experiments

(At least 08 experiments should be done)

Course Outcomes

At the end of the course, a student will be able to:

1. Recognize and eliminate sources of error in measurement of low resistance.
2. Select AC bridge to measure unknown inductance and capacitance.
3. Analyze static and dynamics of electro-mechanical deflecting type instruments.
4. Choosing a standard for calibration and calibrate an instrument.
5. Analyze quality factor and dissipation factor for different loads.
6. Analyze effect of frequency, type of material and volume of material on B-H Curve.
7. Select Q meter for measurement of impedance.
8. Apply oscilloscope techniques for measurement of frequency, phase angle and time delay.
9. Analyze characteristics of sensors for physical parameter measurement.

Experiment List:

1. Measurement of Low Resistance by Kelvin's Double Bridge Method.
2. Measurement of Self Inductance and Capacitance using Bridges.
3. Measurement of Iron Loss from B-H Curve by using CRO.
4. Measurement of R, L, and C using Q-meter.
5. Usage of DSO for steady state periodic waveforms produced by a function generator. Selection of trigger source and trigger level, selection of time- scale and voltage scale. Bandwidth of measurement and sampling rate. Download of one-cycle data of a periodic waveform from a DSO
6. To determine output characteristics of LVDT and measure displacement using LVDT.

7. Measurement of strain using strain gauge.
8. Current measurement using shunt, CT and Hall Sensor.
9. Capacitance and $\tan(\delta)$ measurement of bushings and cables.
10. Measurement of power factor for different loads in a single phase circuit.

B. Tech. 3rd year Autonomous Syllabus

Semester V (Third year)

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|----------------------|-------------------|--|---------------------|---|---|-------------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Core Course | UPCEE501 | Electrical Power Transmission and Distribution | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course | UPCEE502 | Power Electronics | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Core Course | UPCEE503 | Control Systems-I | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Core Course | UPCEE504 | Microprocessors and Microcontrollers | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Programme Elective-I | i) UPEEE501 (I&E) | i. Fundamentals of Communication Theory | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | ii)UPEEE502 | ii. Sensors and Transducers | | | | | | | | |
| | | iii)UPEEE503 | iii. Electrical energy Conservation and Auditing | | | | | | | | |
| 6 | Open Elective-I | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 7 | Lab Course | ULCEE501 | Power Electronics Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCEE502 | Control Systems Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 9 | Lab Course | ULCEE503 | Microprocessors and Microcontrollers Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 22.5 | | | | 900 |

Electrical Power Transmission & Distribution (3-0-0)

Code- UPCEE501

Prerequisites:

1. Basic Electrical Engineering.
2. Electrical Circuit Analysis.

Course Outcomes

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

1. Learn the basics of various fundamentals of electrical power generation, transmission & distribution.
2. Learn transmission line parameters, their calculations also the effects on transmission lines.
3. Learn electrical characteristics of transmission line such as types of transmission lines, various effects on transmission & per unit representation of power system.
4. Learn Mechanical design along with the types of insulators.
5. Learn information regarding conductors and insulation, different types of underground cable parameters and power system earthing.

Module 1: (10 Hours)

Transmission Line Parameters: Inductance of a Conductor due to Internal Flux, Flux Linkages between Two Points External to an Isolated Conductor, Inductance of a Single Phase Two Wire Line, Flux Linkages of One Conductor in a Group, Inductance of Composite-Conductor Lines, Inductance of a Three Phase Line with symmetrical and Unsymmetrical Spacing, Inductance Calculations for Bundled Conductors, Skin effect and Proximity effect, Corona Effect Capacitance of a Two Wire Line, Capacitance of a Three Phase Line with symmetrical and Unsymmetrical Spacing, Effect of Earth on the Capacitance of a Three Phase Line, Capacitance Calculations for Bundled Conductors, Parallel- Circuit Three Phase Lines. Types of conductors: ACSR, AAAC, HTLS etc.

Module 2: (10 Hours)

Transmission Line Performances: Analysis of Short, medium and long Transmission Line, Equivalent Circuit, Representation of lines and calculation of transmission parameters, Voltage Profile of transmission lines, Ferranti Effect, Power Flow Through Transmission Line, Power Flow capability and Surge Impedance Loading, Reactive Compensation of Transmission Line.

Overhead Line Insulators/ Conductors: Insulator Materials, Types of Insulators: Porcelain, Glass, Polymer, Hydrophobicity, Pollution Testing, Creep- age Distance, Voltage Distribution in suspension type insulators, Improvement of String Efficiency, Insulator Failure, Testing of Insulators.

Mechanical Design of Overhead Transmission Lines: General Considerations, Line Supports, Types of towers: H-type, Lattice Type, Suspension, Tangent, Cantilever, GUY. Cross Arms, Span, Conductor Configuration, Spacings and Clearances, ROW, Sag and Tension Calculations, Factors affecting Sag, vibration dampers, Overhead ground wire, (OPGW)

Module 3: (10 Hours)

Distribution: Classification of Distribution Systems, Primary and secondary distribution network, Voltage Drop in DC Distributors, Voltage Drop in AC Distributors, Kelvin's Law, Limitations of Kelvin's Law, Application of Capacitors to Distribution Systems.

Underground Cables: Type and construction, Classification of Cables, Parameters of Single Core Cables, Grading of Cables, Capacitance of Three Core Cable, HVDC Cables, Comparison of overhead lines with underground Cables, XLPE, PVC Cables.

Power System Earthing: Soil Resistivity, Earth Resistance, Tolerable Step and Touch Voltage, Actual Touch and Step Voltages. Single-wire Earth Return Concept in distribution system

Earthing of Transmission Towers (Pipe, Counterpoise), Tower footing Resistance

Text/Reference Books:

1. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
3. J. B. Gupta, "A course in power systems", S K KATARIA & SONS publications.

Power Electronics (3-0-0)

Code- UPCEE502

Prerequisites:

1. Electrical Circuit Analysis.
2. Analog Electronics Circuit
3. Digital System Design

Course Outcomes

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

1. Acquire knowledge of switching characteristics of various Power Semiconductor devices and able to design and simulate their base/gate drive circuits
2. Analyze different controlled rectifier circuits and computing their performances.
3. Analyze different dc-dc converter circuits (isolated and non-isolated type) and computing their performances.
4. Analyze single phase and three phase Voltage Source Inverter circuit topology with SinPWM control, Space Vector PWM control and computing their performances.

Module 1: (12 Hours)

Power switching devices: Thyristor, Power BJT, MOSFET, IGBT: I-V Characteristics and switching characteristics; Firing circuit for Thyristor; Base/Gate drive circuits for Power BJT, MOSFET and IGBT. Protection of power semi-conductor switching devices; SCR, Power BJT, IGBT and Power MOSFET.

Introduction to Wide Band Gap Devices: Gallium Nitride devices and SiC devices as power switching components.

Phase controlled rectifiers: Single-phase full wave fully controlled rectifier with R-L and R-L-E load; Three-phase full wave fully controlled rectifier with R-L and R-L-E load; Input current wave shape and power factor. Single phase semi converter with R-L and R-L-E load, 3 phase semi-converter with R-L and R-L-E load. Effect of source inductance on the performance of full converter.

Module 2: (10 Hours)

DC-DC converter: Elementary chopper with an active switch and diode, power circuit of a buck converter, analysis and waveforms at steady state for continuous and discontinuous load current operations, duty ratio control of out- put voltage. Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage, continuous and discontinuous load current operations, Buck-Boost regulators, Cuk regulators.

Isolated Types: Fly Back Converters, Forward converters, Push Pull Converters, Bridge Converter.

Module 3: (08 Hours)

Voltage source inverter: Single-phase bridge inverter, three-phase inverter: 180° & 120° conduction.

Voltage and frequency control of inverter; single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation (SinPWM), Space Vector PWM of 3-phase inverter.

Current source inverter: 1-phase & 3-phase. Introduction to multilevel inverter

Principle of Cycloconverter

Text/Reference Books:

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Control Systems-I (3-0-0)

Code - UPCEE503

Prerequisites:

1. Understanding of Laplace Transform and Differential Equation Solving.

Course Outcomes

At the end of this course, students will demonstrate the ability to

1. Understand the modelling of linear-time-invariant systems using transfer function and state-space representations.
2. Understand the concept of stability and its assessment for linear-time in-variant systems.
3. Design simple feedback controllers.

Module 1: (10 Hours)

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems.

Feedback Control: Open Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response.

Module 2: (08 Hours)

Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root- Locus technique. Construction of Root-loci.

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion- gain and phase margin. Closed-loop frequency response.

Module 3: (08 Hours)

Stability, steady-state accuracy, transient accuracy, disturbance rejection, in- sensitivity and robustness of control systems. Root-loci method of feedback controller design.

Design specifications in frequency-domain. Frequency-domain methods of de- sign.

Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs.

Module 4: (04 Hours)

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability.

Pole-placement by state feedback.

Text/Reference Books:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
3. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
4. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

Microprocessors and Microcontrollers (3-0-0) Code - UPCEE504

Prerequisites:

1. One must have prior knowledge of programming for problem solving

Course Outcomes

At the end of the course, students will demonstrate the ability to:

1. Do assembly language programming.
2. Do interfacing design of peripherals like I/O, A/D, D/A, timer etc.
3. Develop systems using different microcontrollers.

Module 1: (15 Hours)

Introduction to 8085 Microprocessor & Architecture, Pins & Signal - Instruction set of 8085, Memory & I/O Addressing, Assembly language programming using 8085 Instruction Set, Use of Stack & Subroutines, Data transfer techniques, 8085 interrupts.

Interfacing & support chips: Interfacing EPROM & RAM Memories, 2716, 2764, 6116 & 6264 Microprocessor Based System Development Aids, Programmable Peripheral Interface: 8255, Programmable DMA Controller: 8257, Programmable Interrupt Controller: 8259. Application: Delay calculation, square wave generation, Interfacing of ADC & DAC, Data Acquisition System

Module 2: (08 Hours)

Advanced Microprocessor: Basic features of Advance Microprocessors, Intel 8086 (16 bit processors): - 8086 Architecture, Register organization, signal descriptions, Physical Memory Organization, Addressing Modes, Instruction For- mats, Instructions Sets & Simple Assembly language program.

Module 3: (07 Hours)

8051 Microcontrollers: MCS-51 Architecture, Registers, Stack Pointer & Pro- gram Counter. 8051 Pin Description, Connections, Parallel I/O ports, Memory Organization, 8051 Addressing Modes & Instructions, 8051 Assembly Language Programming Tools.

Simple application: Delay calculation, square wave generation and Interfacing of LCD unit.

Text/Reference Books:

1. Ramesh, Gaonkar," Microprocessor Architecture Programming and Application with the 8085", 5th Edition CBS Publication.
2. A. K. Roy & K. M. Bhurchandi," Advanced Microprocessor and Peripherals (Architecture, Programming & Interfacing)", TMH Publications.
3. D. V. Hall and S. S. S. P. Rao," Microprocessor & its Interfacing"- 3rd Edition, TMH Publication
4. M. A. Mazidi & J. G. Majidi," Microcontroller and Embedded Systems", 2nd Edition, Prentice Hall Publication

Fundamentals of Communication Theory (3-0-0)

Prerequisites:

1. Knowledge of various Analog Hardware & Components.
2. Basics of Calculus.
3. Probability and Statistics.

Course Outcomes

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

1. Apply the knowledge of basic components in communication system.
2. Analyze and design analog communication systems.
3. Evaluate the performance of analog communication in presence of noise.
4. Interpret various radio transmitter and receiver with their parameters.

Module 1: (12 Hours)

Introduction to basic elements of communication systems

Signal transmission through linear systems: condition for distortion less transmission of signals through networks. Different types of distortion and their effect on the quality of output signals, transmission of transient signals, distortion analysis.

Amplitude modulation: Modulation principle and definitions, sideband and carrier power, generation of AM signal, demodulation of AM signal. Different type of modulator circuits, square law modulator, balanced modulator. Demodulator basic principle of coherent detections, square law detectors, average envelope and peak envelope detectors. Quadrature amplitude modulation (QAM), amplitude modulation: single sideband (SSB), generation of SSB signals, selective filtering method, phase shift method, demodulation of SSB-SC signals, envelop detection of SSB signals with a carrier (SSB+C), amplitude modulation: vestigial sideband (VSB), envelop detection of VSB+C signals, noise in AM receivers using envelope detection, concept of SNR.

Module 2: (10 Hours)

Frequency and phase modulation: Principles and definitions, relationship between frequency and phase modulations. phase and frequency deviations, spectrum of FM signal, bandwidth considerations. Effect of modulation index on bandwidth, narrow band and sideband FM and PM principles, circuit for realization of FM and PM. Demodulation: Principle of demodulation: different type of demodulator, discriminator, use of PLL etc.

Module 3: (08 Hours)

Radio transmitter: Basic block diagram of radio transmitter (AM and FM), Analysis of a practical circuit diagram used for medium power transmitter.

Radio receiver: Basic block diagram of TRF, Superheterodyne principle, its advantages, Mixer principle and circuit, AVC, Radio receiver measurement.

System noise calculation: Signal to noise ratio of SSB, DSB, AM for coherent and envelope and square law detection, threshold effect. Signal to noise calculation for FM and threshold.

Text Books:

1. Haykin S.,” Communications Systems”, John Wiley and Sons, 2001.
2. B. P. Lathi, Modern Digital and Analog Communication Systems, Oxford
3. R. P. Singh, S. D. Sapre,” Communication Systems”, TMH, 2nd Edition

Reference Books:

1. Taub H. and Schilling D.L.,” Principles of Communication Systems”, Tata McGraw Hill,2001.
2. Proakis J. G. and Salehi M.,” Communication Systems Engineering”, Pearson Education,2002.
3. Schaum’s Outlines,” Analog and Digital Communication”, 3rd edition

Sensors and Transducers (3-0-0)

Prerequisites:

1. One must have prior knowledge of physics.

Course Outcomes

At the end of the course, a student will be able to,

1. Identify static and dynamic characteristics of general measurement system, identification and compensation of system dynamics.
2. Choose a sensor suitable for measurement of temperature, displacement, strain, force, pressure.
3. Design of signal conditioning circuit for enhancement of sensor signal.

Module 1: (10 Hours)

Elements of a general measurement system: Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems. Techniques for dynamic compensation, loading effect, signal and noise in measurement system, Propagation of errors.

Module 2: (12 Hours)

Sensing elements: Transducers and sensors, Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), Thermistors, strain gauges. Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance, LVDT and RVDT displacement sensors; Electromagnetic sensing elements velocity sensors; ultrasonic, radar, nucleonic type sensing elements, thermoelectric sensing elements: thermocouple laws, characteristics, installation problems, cold junction compensation. IC temperature sensor, Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.

Module 3: (08 Hours)

Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, and filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation.

Text Books:

1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi, 2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh(3/e), PHI Learning, New Delhi, 2009.
3. Measurement Systems Application and Design- E.O. Doebelin (4/e), McGraw- Hill, International, NY.
4. Transducers and Instrumentation- D.V.S. Murthy (2/e), PHI Learning, New Delhi, 2009.

Reference Books:

1. Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. Mc Connel (2/e), John Wiley, NY, 2003.
2. Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.

Electrical Energy Conservation and Auditing (3-0-0) Code - UPEEE503

Prerequisites:

1. Basic Electrical Engineering

Course Outcomes

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

1. Carry out energy accounting and balancing.
2. Perform basic energy audit and suggest energy conservation measures to adopt.
3. Develop the energy price and utilize available resource in an optimal way.
4. Design the illumination of a system by taking account its requirements.

Module 1: (12 Hours)

Electrical energy conservation: Energy economics- discount rate, payback period, internal rate of return, net present value, and life cycle cost. Energy generation, energy distribution, energy usage by processes, technical and economic evaluation, understanding energy costs, classification of energy conservation measures, plant energy performance, benchmarking and energy performance, matching energy usage to requirement, maximizing energy system efficiency, optimizing the input energy requirements, fuel and energy substitution, and energy balancing.

EB billing- HT and LT supply, transformers, electric motors- motor efficiency computation, energy efficient motors, pumps, fans, blowers, compressed air systems, refrigeration and air conditioning systems, cooling towers, electric heaters (space and liquid), DG-sets, illuminating devices, power factor improvement, and harmonics.

Module 2: (12 Hours)

Electrical energy audit: Energy consumption pattern and scenario of any region; Energy auditing: Need, types, methodology and approaches; Preliminary energy audit methodology (initial site visit and preparation required for detailed auditing, detailed energy audit activities, information and data collection, process flow diagram and process steps); Procedure and techniques: Data gathering, evaluation of saving opportunities, and energy audit reporting; and Energy audit instruments.

Module 3: (06 Hours)

Illumination: Illumination, luminous flux, lumen, luminous intensity, candela power, brightness, glare, types of lighting (incandescent, CFL, and LED), requirements of lux for various purposes, determine the method of lighting, select the lighting equipments, and calculate the lighting parameters.

Text/Reference Books:

1. Callaghn, P. W.” Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
2. Dryden. I. G. C.” The Efficient Use of Energy”, Butterworths, London, 1982.
3. Efficient Use of Energy: I.E.C. Dryden (Butterworths).
4. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice Hall).
5. Energy Economics -A. V. Desai (Wiley Eastern).
6. Energy Technology, OP Gupta, Khanna Book Publishing.
7. Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009.
8. Handbook of Energy Efficiency - CRC Press
9. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI, 2006.
10. Howard E. Jordan, Energy-Efficient Electric Motors and Their Applications, Plenum Pub Corp., 2nd edition, 1994.

Power Electronics Lab (0-0-3)

Code- ULCEE501

List of Experiments

(All experiments should be done)

Course Outcomes

At the end of the course, a student will be able to:

1. Acquire knowledge of V-I characteristics of various Power Semiconductor devices and able to design and simulate their base/gate drive circuits
2. Understand the design of cosine controlled triggering circuit of SCR
3. Validate the output performances of different controlled rectifier circuits with various loading conditions.
4. Understand the design of different DC-DC converter circuits (isolated and non-isolated type) and verifying through experimentation.
5. Understand the design and operation of single phase Voltage Source Inverter circuit topology with SinPWM control and simulation of the same circuit in MATLAB-SIMULINK platform.

Experiment List:

1. Study of the V-I characteristics of SCR, TRIAC and MOSFET.
2. Study of the cosine controlled triggering circuit.
3. Study of the single phase half wave controlled rectifier and semi converter circuit with R and R-L Load.
4. Study of single phase full wave controlled rectifier circuits (mid-point and Bridge type) with R and R-L Load.
5. Study of three phase full wave controlled rectifier circuits (Full and Semi converter) with R and R-L Load.
6. Study of the Buck converter and boost converter.
7. Study of the single phase PWM voltage source inverter.
8. Study of the forward converter and flyback converter.

Control System Lab (0-0-3)

Code- ULCEE502

List of Experiments

(At least 08 experiments should be done)

Course Outcomes

At the end of the course, a student will be able to:

1. Understand the modelling of second order systems from experimental data.
2. Understand the concepts of time response and frequency response of Plant/ Process/ Compensators.
3. Design of controller such as ON-OFF, PID, Lead-Lag etc. for different 1st and 2nd order systems.

Experiment List:

1. Characteristics of DC and AC servo motors.
2. Step response of second order system.
3. Temperature Control system.
4. Closed loop P, PI and PID controller.
5. DC position control system.
6. AC position control system.
7. Frequency response of compensating networks.
8. Step response and Frequency response of a given plant.
9. Design of lag and lead compensation for a given plant.
10. System Identification of DC motor using MATLAB/LabVIEW.
11. Compensator design for a low pass filter and realize using OP-Amp circuit.

Microprocessors & Microcontrollers Lab (0-0-3)

Code - ULCEE503

List of Experiments

(At least 08 experiments should be done)

Course Outcomes

At the end of the course, a student will be able to:

1. Understand the ability to write Assembly language and Machine level programming.
2. Understand the interfacing design of various peripherals like I/O, ADC, DAC, timers etc.
3. Design of systems using microprocessor or micro-controller.

Experiment List:

1. Write program for addition, subtraction, multiplication and division operation.
2. Sorting of data in ascending and descending order.
3. Square root of a given data.
4. To generate a square wave of frequency 10kHz (similar).
5. Interfacing with ADC and DAC.
6. Implementation and Interfacing of Seven segment display.
7. Implementation and Interfacing of different motors like stepper motor, DC motor and servo motor.
8. To measure and display data from temperature and pressure sensor.

9. To interface a graphical LCD.
10. To study programming and transmission of data through serial and parallel port.

Semester VI (Third year)

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|--|----------------|---------------------------------------|---------------------|---|---|-----------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Core Course | UPCEE601 | Power System Operation and Control | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course | UPCEE602 | Electric Drives | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Programme Elective-II | UPEEE601 | i. Renewable Energy Systems | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | UPEEE602 | ii. Electric and Hybrid Vehicles | | | | | | | | |
| | | UPEEE603 | iii. Special Electric Machines | | | | | | | | |
| 4 | Programme Elective-III | UPEEE604 | i. High Voltage Engineering | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | UPEEE605 (I&E) | ii. Digital Signal Processing | | | | | | | | |
| | | UPEEE606 | iii. Electrical Engineering Materials | | | | | | | | |
| 5 | Open Elective-II | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Lab Course | ULCEE601 | Power System Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 7 | Lab Course | ULCEE601 | Electric Drives Laboratory | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCEE601 | Design and Simulation Laboratory | 0 | 0 | 4 | 2 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 20 | | | | 800 |
| 9 | Summer Internship programme (4 to 8 weeks) is mandatory as per AICTE rule | | | | | | | | | | |

Power System Operation and Control (3-0-0) Code- UPCEE601

Prerequisites:

1. Electrical Circuit Analysis.
2. Electrical Power transmission and Distribution.

Course Outcomes

At the end of this course, students will demonstrate the ability to

1. Use numerical methods to analyze a power system in steady state.
2. Understand stability constraints in a synchronous grid.
3. Understand methods to control the voltage, frequency and power flow.
4. Understand the monitoring of a power system.
5. Understand the basics of power system economics.

Module 1: (12 Hours)

Power Flow Analysis: Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non-linear algebraic equations - Gauss Seidel, Newton-Raphson methods and Decoupled load flow method for the solution of the power flow equations.

Power System Economics: Basic Pricing Principles: Generator Cost Curves, Utility Functions, Economic Operation with and without Transmission losses, Transmission loss coefficient, Economic Dispatch, Unit Commitment, Function of Load Dispatch Centres.

Module 2: (10 Hours)

Control of Frequency and Voltage: Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators, ALFC of Single and Two Area Systems.

Symmetrical components and Fault Analysis.

Module 3: (08 Hours)

Power System Stability: Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three-phase fault. Analysis using the Equal Area Criterion. Voltage Stability and Voltage Collapse.

Text/Reference Books:

1. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.

2. J. Grainger, W. D. Stevenson and G. W. Chang," Power System Analysis", McGraw Hill Education, 2015
3. O. I. Elgerd," Electric Energy Systems Theory", McGraw Hill Education, 1995.
4. A. R. Bergen and V. Vittal," Power System Analysis", Pearson Education Inc., 1999.
5. D. P. Kothari and I. J. Nagrath," Modern Power System Analysis", McGraw Hill Education, 2003.
6. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac," Electric Power Systems", Wiley, 2012.
7. Prabha Kundur," Power System Stability and Control", McGraw Hill Inc., Indian Edition

Electric Drives (3-0-0)

Code- UPCEE602

Prerequisites:

1. Power Electronics.
2. Control Systems.
3. Electrical Machines.

Course Outcomes

At the end of this course, students will demonstrate the ability to

1. Acquire knowledge of various speed control techniques of three phase induction motor (slip ring and squirrel cage) using different converters.
2. Acquire knowledge of speed control of separately excited DC motor using phase controlled rectifier and choppers.
3. Understand the formulation of transfer function of DC motors.

Module 1: (10 Hours)

Advantages of Electrical Drives, Fundamentals of Torque Equations, Speed Torque Conventions and Multi-Quadrant Operation, Equivalent Values of Drive Parameters, Components of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization, Control of Electrical Drives, Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating.

Module 2: (10 Hours)

DC Motor Drive: Starting, Braking, Speed Control, Methods of Armature Voltage Control, Controlled Rectifier Fed separately excited DC motor drives- steady state operation, Chopper fed separately excited DC motor drive-steady state operation, armature current waveform and ripple.

Closed-loop control of DC Drive: Control structure of DC drive, inner current loop and outer speed loop, dynamic model of separately excited DC motor and transfer functions, modelling of chopper as gain with

switching delay, plant transfer function, controller design, current controller specification and design, speed controller specification and design.

Module 3: (10 Hours)

Induction Motor Drives: Speed Control of three phase induction motor, Pole Changing, Pole Amplitude Modulation, Stator Voltage Control, V/f control of induction motor- steady-state performance analysis based on equivalent circuit, slip regulation.

Control of slip ring induction motor: Impact of rotor resistance on three phase induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, power electronic based rotor side control of slip ring induction motor, slip power recovery schemes. Static Scherbius and Kramer drives.

Special Motor Drives: Brief introduction to Permanent Magnet Synchronous Motor drives and BLDC motor drives, Traction motor drives.

Text/Reference Books:

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

Renewable Energy Systems (3-0-0)

Code- UPEEE601

Prerequisites:

1. Power Electronics.

Course Outcomes

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

1. Analyze the energy scenario and the consequent growth of the power generation from renewable energy sources.
2. Explain the basic physics of wind and solar power generation.
3. Synthesize the power electronic interfaces for wind and solar generation.
4. Resolve the issues related to the grid-integration of solar and wind energy systems.

Module 1: (08 Hours)

Wind Generator Topologies: Wind power statistics of India and world, Wind physics; roll, yaw and pitch; Betz limit, tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions.

Review of modern Wind turbine technologies, fixed and variable speed Wind turbines, induction generators, doubly fed induction generators and their characteristics, permanent-magnet synchronous generators, power electronics converters, generator-converter integration configurations, control of converters.

Module 2: (08 Hours)

Solar Photovoltaic and Solar Thermal Power Generation: Solar photovoltaic: Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, power electronic converters for solar systems, maximum power point tracking (MPPT) algorithms, control of converters.

Inverter Specifications for Solar Applications (From MNRE, SECI, and other sources)

Solar thermal: Technologies, parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Module 3: (08 Hours)

Network Integration Issues: Overview of technical grid code requirements, fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues, power system interconnection (global single network) experiences in the world.

Hybrid and isolated operations of solar PV and wind systems.

Module 4: (06 Hours)

Biomass Power: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Types of biogas digester, Wood gasifier, Pyrolysis, Applications. Bio gas, Wood stoves, Bio diesel, Combustion engine, Application.

Brief idea on Fuel cells and Battery Storage Technology.

Text/Reference Books:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems", John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.
7. C. S. Solanki, "Solar Photovoltaics Fundamentals, Technologies and Applications", PHI Learning Private limited, third edition April 2015.

Electric and Hybrid Vehicles (3-0-0)**Code- UPEEE602****Prerequisites:**

1. Power Electronics.

2. Electrical Machines.

Course Outcomes

After successfully completing this course a student will be able to:

1. Understand the operating principles of the electrical machines involved in hybrid cars.
2. Understand other power electronic circuits such as chargers and auxiliary drives used in vehicles.
3. Choose the battery, traction motor and transmission appropriate for the power train of an EV or HEV.
4. Analyze hybrid and electric vehicle power train systems to establish their optimal structure and calibration.

Module 1: (08 Hours)

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

Module 2: (08 Hours)

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module 3: (08 Hours)

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

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

Module 4: (06 Hours)

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

Battery Management System(BMS)/Energy Management System (EMS): Need of BMS, Rule based control and optimization based control, Software- based high level supervisory control, Mode of power transfer, Behavior of drive motor.

Electric Vehicles charging station: Type of Charging station, Selection and Sizing of charging station.

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

Reference Books:

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

Special Electrical Machines (3-0-0)

Code- UPEEE603

Prerequisites:

1. Electrical Machines - I.
2. Electrical Machines - II.

Course Outcomes

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

1. Identify and differentiate various electrical machines.
2. Know the operation of stepper motor to implement for robotic applications.
3. Know the various operating modes SRM.
4. Know the operation of conventional DC and BLDC.

Module 1: (10 Hours)

Stepper Motor: Constructional features, Principle of operation, PM stepping motors, Variable reluctance motor, Hybrid motor, Single and multi-stack configurations. Torque equations, Modes of excitation, Characteristics. Drive circuits, Microprocessor control of stepper motors, Closed loop Control, Concept of lead angle and Applications.

Switched Reluctance Motor: Constructional features, Rotary and Linear SRM, Principle of operation, Torque production. Steady state performance prediction, Analytical method, Power Converters and their controllers. Methods of Rotor position sensing, Sensor less operation. Characteristics and Closed loop control and Applications.

Module 2: (10 Hours)

Permanent Magnet Brushless D.C. Motor: Permanent Magnet materials, Minor hysteresis loop and recoil Line. Magnetic Characteristics, Permeance coefficient. Principle of operation, Types, Magnetic circuit analysis, EMF and torque equations. Commutation. Torque speed characteristics. Power Converter Circuits and their controllers, Motor characteristics and control, Rotor position sensing, Sensorless motors Applications.

Module 3: (10 Hours)

Permanent Magnet Synchronous Motor: Construction, Principle of operation, Ideal PMSM, EMF and Torque equations, Armature MMF, Synchronous Reactance. Sine wave motor with practical windings,

Phasor diagram. Torque/ speed characteristics, Power controllers, Converter Volt-ampere requirements, Starting and Applications.

Synchronous Reluctance Motor: Constructional features, Types, Axial and Radial flux motors, Operating principles, Variable Reluctance Motors, Voltage and Torque Equations, Phasor diagram, performance characteristics and Applications.

Text Books:

1. Miller, T. J. E., Brushless Permanent Magnet and Reluctance Motor Drives, Oxford Science Publications, 1989.
2. Kenjo, T., and Sugawara, A., Stepping Motors and their Microprocessor Controls, Oxford Science Publications, 1984.
3. Venkataratnam K., Special Electrical Machines, CRC Press, 2009.

Reference Books:

1. R. Krishnan, 'Switched Reluctance Motor Drives - Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.
2. P. P. Aearnley, 'Stepping Motors - A Guide to Motor Theory and Practice', Peter Perengrinus London, 1982.
3. T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
4. E. G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

High Voltage Engineering (3-0-0)

Code- UPEEE604

Prerequisites:

1. Physics.
2. Electrical Power Transmission and Distribution.

Course Outcomes

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

1. Understand breakdown phenomena in gases, liquids and solids.
2. Know the concepts used for the generation of high voltages and currents.
3. Know the concepts used for the measurement of high voltages and currents.
4. Understand high voltage testing techniques and protection schemes of power apparatus.

Module 1: (10 Hours)

Conduction and Breakdown in Gases: Gases as Insulating Media, Collision Processes, Ionization Processes, Townsend's Current Growth Equation, Townsend's Criterion for Breakdown, Experimental Determination

of Coefficients α and γ , Breakdown in Electronegative Gases, Time Lags for Break-down, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-uniform Fields and Corona Discharges, Post-Breakdown Phenomena and Applications, Practical Considerations in using Gases and Gas Mixtures for Insulating Purposes Vacuum Insulation.

Module 2: (10 Hours)

Conduction and Breakdown in Liquid Dielectrics: Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids.

Breakdown in Solid Dielectrics: Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown, Breakdown of Solid Dielectrics in Practice, Breakdown in Composite Dielectrics, Solid Dielectrics used in Practice.

Generation of High Voltages and Currents: Generation of High Direct Current Voltages, Generation of High Alternating Voltages, Generation of Impulse Voltages, Generation of Impulse Currents.

Module 3: (10 Hours)

Measurement of High Voltages and Currents: Measurement of High Direct Current Voltages, Measurement of High AC and Impulse Voltages, Measurement of High Currents: Direct, Alternating and Impulse.

Non-Destructive Testing of Materials & Electrical Apparatus: Measurement of Direct Current Resistivity, Measurement of Dielectric Constant and Loss Factor, Partial Discharge Measurements, Ultrasonic, PRPD technique for measurement.

High Voltage Testing of Electrical Apparatus: Testing of Insulators, Bushings, Isolators, Circuit Breakers, Cables, Transformers and Surge Arresters, Insulation Coordination.

Insulation Coordination: Power frequency, Switching, Lightning withstand level, BIL of different voltage class, Outdoor clearance, Surge arrestors: types, operating principle, Basic principle of insulation coordination.

Text Books:

1. M. S. Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw- Hill, 6th Edition 2015.

Reference Books:

1. E. Kuffel and W. S Zaengel, 'High voltage engineering Fundamentals', Pergamon Press Oxford, London, 1986.
2. L. L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition, 2011.
3. C. L. Wadhwa, 'High Voltage Engineering', New Age International Publishers.

Digital Signal Processing (3-0-0)

Prerequisites:

1. Mathematics.
2. Signals and Systems.

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
2. Analyze discrete-time systems using z-transform.
3. Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. Design digital filters for various applications.

Module 1: (10 Hours)

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate. z-Transform, Region of Convergence, Analysis of Linear Shift In-variant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z transforms.

Module 2: (10 Hours)

Discrete Fourier Transform: Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Module 3: (10 Hours)

Design of Digital filters: Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High pass filters.

Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

Text/Reference Books:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A. V. Oppenheim and R. W. Schaffer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas and W. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

Electrical Engineering Materials (3-0-0)

Code- UPEEE606

Prerequisites:

1. Physics.

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Be aware of various aspects of conductivity of material.
2. Know about the various dielectric properties of material.
3. Know about the various magnetic properties of material.
4. Be aware of factors affecting properties of material.
5. Know about the properties of semiconductors.
6. Be aware of application areas of electrical engineering materials.

Module 1: (08 Hours)

Conductivity of Metal: Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field emission, effect of temperature on electrical conductivity of metals, electrical conducting materials, thermal properties, thermal conductivity of metals, thermoelectric effects.

Module 2: (08 Hours)

Dielectric Properties: Introduction, effect of a dielectric on the behavior of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity, dielectric losses, significance of the loss tangent, dipolar relaxation, frequency and temperature dependence of the dielectric constant, dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, ferroelectricity, piezoelectricity.

Module 3: (07 Hours)

Magnetic properties of Materials: Introduction, Classification of magnetic materials, diamagnetism, paramagnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance.

Module 4: (07 Hours)

Semiconductors: Energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semi- conductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

Text Books:

1. C. S. Indulkar and S. Thiruvengadam, S., "An Introduction to Electrical Engineering Materials", S. Chand and Company Ltd. Publisher.
2. Kenneth G. Budinski, "Engineering Materials", PHI Publisher.

Reference Books:

1. S. P. Seth, "A Course In Electrical Engineering Materials", Dhanpat Rai Publisher.
2. Technical Teachers Training Institute, Madras, "Electrical Engineering Materials", TMH Publisher

Power Systems Lab (0-0-3) Code- ULCEE601

List of Experiments

(At least 10 experiments should be done)

Course Outcomes

At the end of the course, a student will be able to:

1. Analyze the operation and working of different types of relays.
2. Analyze the sequence impedances of a machine and understand the importance in fault studies.
3. Calculate the parameters of a transmission line.
4. Calculate the Y-bus and its use in power flow solutions.

Experiment List:

Hardware Based:

1. To determine negative and zero sequence synchronous reactance of an alternator.
2. To determine sub-transient direct axis and sub-transient quadrature axis synchronous reactance of a 3-ph salient pole alternator.
3. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
4. To study the IDMT over-current relay and with different plug setting and time setting multipliers and plot its time - current characteristics.
5. To determine the operating characteristics of biased differential relay with different
6. To study the MHO and reactance type distance relays.
7. To determine A, B, C, D parameters of an artificial transmission line.
8. To compute series inductance and shunt capacitance per phase per km of a three phase line with flat horizontal spacing for single stranded and bundle conductor configuration.
9. To determine location of fault in a cable using cable fault locator.

10. To study the Ferranti Effect and voltage distribution in HV long transmission line using transmission line model.
11. Insulation test for Transformer oil.
12. Study of various types of Lightning arrestors.

Simulation Based (Using MATLAB):

1. To obtain steady-state, transient and sub-transient short-circuit currents in an alternator.
2. To formulate the Y-Bus matrix and perform load flow analysis.
3. To compute voltage, current, power factor, regulation and efficiency at the receiving end of a three phase Transmission line when the voltage and power at the sending end are given. Use π model.
4. To perform symmetrical fault analysis in a power system.
5. To perform unsymmetrical fault analysis in a power system.
6. Write a program to solve economic dispatch problem of a power system with only thermal units. Take production cost function as quadratic and neglect transmission loss.

Electric Drives Lab (0-0-3) Code- ULCEE601

List of Experiments

(At least 08 experiments should be done)

Course Outcomes

At the end of the course, a student will be able to:

1. Acquire knowledge of various speed control techniques of three phase induction motor (slip ring and squirrel cage) using different converters.
2. Acquire knowledge of speed control of separately excited DC motor using phase controlled rectifier and choppers.
3. Understand the formulation of transfer function of DC motors.

Experiment List:

1. Speed Control of Single Phase Induction Motor by using Single Phase AC to AC Converter.
2. Speed Control of Separately Excited DC Shunt Motor using Single Phase Fully Controlled AC to DC Converter.
3. Speed Control of Separately Excited DC Shunt Motor using Four-Quadrant Chopper.
4. Speed Control of Separately Excited DC Shunt Motor using Single Phase Dual Converter.
5. Speed Control of Three Phase Squirrel Cage Induction Motor using Three Phase AC to AC Controller.

6. Speed Control of Three Phase Squirrel Cage Induction Motor using Variable Voltage Variable Frequency Three Phase PWM Inverter.
7. Speed Control of Three Phase Slip Ring Induction Motor using Rheostatic Control Method.
8. Speed Control of DC Shunt Motor using Three Phase AC to DC Converter.
9. Determination of the Transfer Function of DC Shunt Motor.
10. Determination of the Moment of Inertia of DC Shunt Motor Drive System by Retardation Test.

Design and Simulation Lab (0-0-4)

Code- ULCEE601

List of Experiments

(All experiments should be done)

Course Outcomes

At the end of the course, a student will be able to:

1. Acquire knowledge of design criteria of different machines according to their specifications.
2. Apply and validate the concepts of stability in Control Systems.
3. Apply the concepts of compensator and controllers according to design specifications.
4. Apply and validate the concepts of topologies and waveforms in different Power Electronics Circuits.

Experiment List:

1. Analyze the characteristics of the step and ramp response for a first and second order system.
2. Design a compensator according to the requirements of the system.
3. Analyze the effect of P, PI, and PID on a system.
4. Design and compare the uncontrolled rectifier in 1-phase and 3-phase with R, RL and RLE load.
5. Design and compare the controlled rectifier in 1-phase with R, RL and RLE load.
6. Design and compare the controlled rectifier in 3-phase with R, RL and RLE load.
7. Design and compare the 1-phase VSI inverter with R, RL load.
8. Design and compare the 3-phase VSI inverter with R, RL load.
9. Design and compare the 1-phase step-up and step-down cycloconverter with R, RL load
10. Design and analyze the ac voltage controller
11. Design buck and boost converter
12. Design a transformer and find its efficiency and regulation curves.

Design and Performance Analysis of Electrical Machines using ANSYS MAXWELL software

(Any Other Experiments can be done according to the interest of the instructor/professor taking the class)

Syllabus for B. Tech. 4th year Autonomous Syllabus

Semester VII (Fourth year)

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|---------------------------|---------------|--|---------------------|---|---|-----------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Programme Elective-IV | i)UPEEE701 | i. Power System Protection & Switchgear | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | ii)UPEEE702 | ii. Power System Dynamics and Control | | | | | | | | |
| 2 | Programme Elective-V | i)UPEEE703 | i. Control Systems -II | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | ii)UPEEE704 | ii. Control System Design | | | | | | | | |
| | | iii) UPEEE705 | ii. EHVAC Transmission | | | | | | | | |
| 3 | Open Elective-III | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Open Elective-IV | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Humanities Science Course | UHSMH701 | Marketing Management/ Entrepreneurship Development | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Project Course | UPREE701 | Project Stage-1 | 0 | 0 | 6 | 3 | 0 | 0 | 100 | 100 |
| 7 | Seminar | USEEE701 | Internship Seminar | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 19 | | | | 700 |

Power System Protection and Switchgear (3-0-0)

Code- UPEEE701

Prerequisites:

1. Power System Operation and Control.
2. Electrical Power Transmission & Distribution.

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Understand the different components of a protection system.
2. Evaluate fault current due to different types of fault in a network.
3. Understand the protection schemes for different power system components.
4. Understand the basic principles of digital protection.
5. Understand system protection schemes, and the use of wide-area measurements.

Module 1: (10 Hours)

Introduction and Components of a Protection System: Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers.

Faults and Over-Current Protection: Review of Fault Analysis, Sequence Networks. Introduction to Overcurrent Protection and overcurrent relay co- ordination.

Module 2: (10 Hours)

Equipment Protection Schemes: Directional, Distance, Differential protection. Transformer and Generator protection. Bus bar Protection, Bus Bar arrangement schemes.

Digital Protection: Computer-aided protection, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues.

Module 3: (10 Hours)

System Protection: Effect of Power Swings on Distance Relaying. System Protection Schemes. Under-frequency, undervoltage and df/dt relays, Out-of- step protection, Synchro-phasors, PMU.

Switchgears: Auto reclosing, Theory of Circuit interruption, Circuit constants in relation to Circuit breaking, Re-striking voltage transient, characteristics of Re-striking Voltage, Interaction between breaker and circuit, Current chopping.

Circuit Breakers: Types of circuit breakers (air blast, air break, oil, vacuum, SF₆, DC circuit breaker), advantages and testing of circuit breaker.

Text Books:

1. Computer Relaying for Power Systems, Second Edition, Arun G. Phadke, James S. Thorp, John Wiley and Sons, Ltd., Publication

2. Power System Protection, P. M. Anderson, Power Math Associates, Inc., IEEE Press Power Engineering Series, P.M. Anderson, Series Editor
3. Power System Relaying, Third Edition, Stanley H. Horowitz, Arun G. Phadke, John Wiley & Sons, Ltd.
4. Fundamentals of Power System Protection, Y. G. Paithankar and S. R. Bhide, 2nd Edition, PHI Publications

Power System Dynamics and Control (3-0-0)

Code- UPEEE702

Prerequisites:

1. Power System Operation and Control.
2. Electrical Power Transmission & Distribution.

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Analyze and model main power system components such as synchronous machines, excitation systems and governors
2. Understand Fundamental dynamic behavior and controls of power systems to perform basic stability analysis
3. Model and simulate the dynamic phenomena of power systems
4. Interpret results of system stability studies

Module 1: (10 Hours)

Synchronous Machine Theory and Modeling: Physical description, mathematical description of asynchronous machine, the dq0 transformation, equivalent circuit for direct and quadrature axes, steady-state analysis, Electrical transient performance characteristics, Equation of motion.

Module 2: (10 Hours)

Power System Stability Problems: Basic concepts and definitions, Rotor angle stability, Synchronous machine characteristics, Power versus angle relationship, Stability phenomena, Voltage stability and voltage collapse, Mid-term and long-term stability, Classification of stability.

Small Signal Stability: State space concepts, Basic linearization technique, Participation factors, Eigen properties of state matrix, small signal stability of a single machine infinite bus system, Stability improvement by power system stabilizers. Design of power system stabilizers, Voltage stability, System oscillations.

Module 3: (10 Hours)

Excitation system requirements: Elements of an Excitation system, types of Excitation Systems. AC, DC & Static excitation systems. Dynamic performance measures, control and protection functions, modeling of excitation systems.

Sub-synchronous Oscillation: Turbine generator torsional characteristics. Torsional Interaction with power system controls, sub-synchronous resonance, counter measures to SSR problems.

Text/Reference Books:

1. Prabha Kundur, Power system stability and control, Tata McGraw-Hill, 1994
2. P. Sauer and M. Pai, Power system dynamics and stability, Prentice Hall, 1998.
3. R. Ramanujam, Power system Dynamics, PHI Publication
4. P. M. Anderson and A. A. Fouad, "Power Control and Stability", IEEE press.

Control systems-II (3-0-0)

Code- UPEEE703

Prerequisites:

1. Control System-I.

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Obtain discrete representation of LTI systems.
2. Analyze stability of open loop and closed loop discrete-time systems.
3. Design and analyze digital controllers.
4. Learn about analysis of Non-Linear Systems.

Module 1: (10 Hours)

Discrete - Time Control Systems: Introduction: Discrete Time Control Systems and Continuous Time Control Systems, Sampling Process. Sample and Hold, The Z-transform: Discrete-Time Signals, The Z-transform, Z-transform of Elementary functions, Important properties and Theorems of the Z-transform. The inverse Z transform, Z Transform method for solving Difference Equations. Z-Plane Analysis of Discrete Time Control Systems: Impulse sampling & Data Hold, Reconstruction of Original signals from sampled signals: Sampling theorem, folding, aliasing. Pulse Transfer function: Starred Laplace Transform of the signal involving Both ordinary and starred Laplace Transforms; General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems. Mapping between the s-plane and the z-plane, Stability analysis of closed loop systems in the z-plane: Stability analysis by use of the Bilinear Transformation and Routh stability criterion, Jury stability Test

Module 2: (08 Hours)

State Space Approach for discrete time systems: State space models of discrete systems, State space analysis. Lyapunov Stability, Controllability, observability analysis. Effect of pole zero cancellation on the controllability & observability.

Module 3: (12 Hours)

Non-linear Systems: Introduction, Common Physical Non-linearities, The Phase-plane Method: Basic Concepts, Singular Points, Stability of Nonlinear System, Construction of Phase-trajectories, The Describing Function Method: Basic Concepts, Derivation of Describing Functions, Stability analysis by Describing Function Method, Jump Resonance, Signal Stabilization.

Liapunov's Stability Analysis: Introduction, Liapunov's Stability Criterion, The Direct Method of Liapunov and the Linear System, Methods of Constructing Liapunov Functions for Non-linear Systems.

Text Books:

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
4. B. C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.
5. H. K. Khalil, Non Linear Systems, 3rd edition (2002), Pearson Education
6. B. Friedland, Control System Design - An Introduction to State-Space Methods, McGraw-Hill, 2007
7. S. H. Zak, Systems and Control, Oxford Univ. Press, 2003

Control Systems Design (3-0-0)

Code- UPEEE704

Prerequisites:

1. Control System-I.

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Understand various design specifications.
2. Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID compensators).
3. Design controllers using the state-space approach.

Module 1: (12 Hours)

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.

Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.

Module 2: (10 Hours)

Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback - Feed forward control.

Module 3: (08 Hours)

Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.

Text/Reference Books:

1. N. Nise, "Control system Engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
4. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
5. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.
6. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.
7. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994.

EHVAC Transmission (3-0-0)

Code - UPEEE705

Prerequisites:

1. Electrical Power Transmission and Distribution.

Course Outcomes

On completion of this course, the student will be able to:

1. Understand the importance of EHV AC transmission

2. Estimate choice of voltage for transmission, line losses and power handling capability of EHV Transmission.
3. Analyze by applying the statistical procedures for line designs, scientific and engineering principles in power systems.

Module 1: (10 Hours)

E.H.V.A.C. Transmission line trends and preliminary aspect standard transmission voltages, Average value of Line parameter, Power handling capacity and line loss, Major EHV AC lines in India, types of Vibration and Oscillation, Dampers and Spacer - Estimation at line and ground Parameters-Bundle Conductor Systems-Inductance and Capacitance of E.H.V. lines - positive, negative and zero sequence impedance - Line Parameters for Modes of Propagation.

Line and ground reactive parameters: Line inductance and capacitances - sequence inductances and capacitances - modes of propagation - ground return - Examples.

Voltage gradients of conductors: Electrostatics - field of sphere gap - field of line charges and properties - charge - potential relations for multi-conductors - surface voltage gradient on conductors - distribution of voltage gradient on sub-conductors of bundle - Examples.

Module 2: (10 Hours)

Corona effects - I: Power loss and audible noise (AN) - corona loss formulae - charge voltage diagram - generation, characteristics - limits and measurements of AN - relation between 1-phase and 3-phase AN levels - Examples.

Corona effects - II: Radio interference (RI) - corona pulses generation, properties, limits - frequency spectrum - modes of propagation - excitation function - measurement of RI, RIV and excitation functions - Examples.

Electro static field: Electrostatic field: calculation of electrostatic field of EHV/AC lines - effect on humans, animals and plants - electrostatic induction in unenergised circuit of double-circuit line - electromagnetic interference- Examples.

Module 3: (10 Hours)

Travelling wave theory: Travelling wave expression and solution- source of excitation- terminal conditions- open circuited and short-circuited end- reflection and refraction coefficients-Lumped parameters of distributed lines-generalized constants-No load voltage conditions and charging current.

Voltage control: Power circle diagram and its use - voltage control using synchronous condensers - cascade connection of shunt and series compensation - sub synchronous resonance in series capacitor - compensated lines - static VAR compensating system.

Lightning and Lightning Protection: Lightning strokes to lines and mechanism, Lightning Protection, Tower footing Resistance. Lightning Arrester and Protective Characteristic.

Text Books:

1. R. D. Begamudre, "EHVAC Transmission Engineering", New Age International (p) Ltd. 3rd Edition.

2. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International (p) Ltd. 2nd revised Edition, 2012.

Reference Books:

1. S. Rao, "EHVAC and HVDC Transmission Engineering Practice", Khanna publishers.
2. Arrillaga J., "High Voltage Direct Current Transmission", 2nd Edition (London) Peter Peregrines, IEE, 1998.
3. Padiyar K. R., "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007.
4. Hingorani H. G. and Gyugyi L., "Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems", New York, IEEE Press, 2000.

Marketing Management (3-0-0)

Prerequisites:

1. Organizational Behaviour.
2. English.

Module 1: (10 Hours)

Fundamentals of Marketing: Marketing Management: Concept, Process, Functions and relevance in the current context. Concepts of Marketing Mix - 4Ps.

Marketing Environment: Micro and Macro environment. Market Segmentation: Demographic and Psychographic, STP.

Module 2: (10 Hours)

Product Development, Branding, Packaging, Labeling, Brand Equity, Product Line Vs Product Mix, Product Life Cycle;

Pricing Methods: Cost Plus, Penetration, Skimming, Mark-up. Place: Channels of Distribution; Mark down Levels, SCM concept.

Module 3: (10 Hours)

Promotion: IMC concept.

Emerging Marketing Trends: CRM, Green Marketing, e-marketing, Social Marketing; Societal Marketing.

Text/Reference Books:

1. "Marketing Management", Kotler, Keller, Koshy and Jha, Pearson Education.
2. "Marketing Management", Saxena, Tata McGraw Hill.

Entrepreneurship Development (3-0-0)

Prerequisites:

1. Organizational Behaviour.
2. English.

Module 1: (06 Hours)

Entrepreneurship: Concept of Entrepreneurship and Intrapreneurship, Types of Entrepreneur, Nature and Importance, Entrepreneurial Motivation and Achievement, Entrepreneurial Personality & Traits and Entrepreneurial Skills.

Module 2: (08 Hours)

Entrepreneurial Environment, Identification of Opportunities, Converting Business, Opportunities into reality. Start-ups and business incubation, Skill Development. Setting up a Small Enterprise. Issues relating to location, Environmental Problems and Industrial Policies and Regulations.

Module 3: (08 Hours)

Basics of Accounting, Terms: Assets, Liabilities, Equity, Revenue, Expense, Working capital, Marketing Mix and STP.

HRM: Concepts and Function, Labour Laws- Factories Act, Organizational support services - Central and State Government, Incentives and Subsidies.

Module 4: (08 Hours)

Sickness of Small-Scale Industries, Causes and symptoms of sickness, cures of sickness, Role of Banks and Government in reviving sick industries.

Text Books:

1. Entrepreneurship Development and Management, Vasant Desai, HPH.
2. Entrepreneurship Management, Bholanath Dutta, Excel Books.
3. Entrepreneurial Development, Sangeeta Sharma, PHI.
4. Entrepreneurship, Rajeev Roy, Oxford University Press.

Semester VIII (Fourth year)

| Sl. No. | Subject Type | Subject Code | Subject Name | Teaching Hours/Week | | | Credit | Maximum Marks | | | |
|---------|-----------------------|--------------|---|---------------------|---|----|-----------|---------------|----|-----|------------|
| | | | | L | T | P | | IA | EA | PA | Total |
| 1 | Programme Elective-VI | i)UPEEE801 | i. Power Quality and Custom Power Devices | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| | | ii)UPEEE802 | ii. HVDC and FACTs for Transmission Systems | | | | | | | | |
| | | iii)UPEEE803 | iii. Advanced Electric Drives | | | | | | | | |
| | | iv)UPEEE804 | iv. Industrial Electrical Systems | | | | | | | | |
| 2 | Open Elective-V | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Open Elective-VI | | | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Project Course | UPREE801 | Project Stage-2 | 0 | 0 | 14 | 7 | 0 | 0 | 100 | 100 |
| 5 | Core Course | UPCEE801 | Comprehensive Viva Voce | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
| | | | Total | | | | 17 | | | | 500 |

Power Quality and Custom Power Devices (3-0-0) Code - UPEEE801

Prerequisites:

1. Power System Operation and Control.
2. Power Electronics.

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Understand the characteristics of AC transmission and the effect of shunt and series reactive compensation.
2. Understand the basic concepts of power quality.
3. Understand the working principles of devices to improve power quality.

Module 1: (10 Hours)

Overview and definition of power quality (PQ): Sources of pollution and regulations, Power quality problems, Various IEEE, IEC, ANSI standards, Power acceptability curves.

Rapid voltage fluctuations voltage unbalance, Voltage dips and voltage swells, Short duration outages.

Definitions Voltage sag analysis and mitigation: Sag caused by motor starting, Sag caused by utility fault clearing, Sag mitigation, Sag magnitude and duration calculations, RMS voltage, Peak examples of sag magnitude, Calculation in 1-phase systems, Equipment performance in presence of sag, (Computers, AC and DC drives).

Module 2: (10 Hours)

Harmonics: Effects-within the power system, Interference with communication systems, harmonic measurements.

Harmonic distortion: Power system harmonics, Harmonic analysis, Harmonic sources-the static converters, Transformer magnetization and non-linearities, Rotating machines, Arc furnaces, Fluorescent lighting. Introduction to power converters, Fourier analysis, Total harmonic distortion, RMS and average value calculations, Arcing and saturable devices, Effects of harmonic distortion, System response characteristics.

Module 3: (10 Hours)

Mitigation Techniques and Devices: Passive filters and their design. Active Filters - D-STATCOM, DVR, UPQC, IPFC.

Monitoring power quality: Monitoring essentials, Power quality measuring equipment - Disturbance Analyzer, Power Quality Analyzer.

Text Books:

1. Beaty, H. and Santoso, S., Electrical Power System Quality, McGraw Hill (2002).

2. Kennedy, B., Power Quality Primer, McGraw Hill (2000).
3. Bollen, M.H.J., Power Quality Problems: Voltage Sag and Interruptions, IEEE Press (2007).
4. Mohan, N., Power Electronics, New Age International (P) Limited, Publishers (2007).
5. R. C. Duggan, 'Power Quality', TMH Publication, 2012
6. Arindam Ghosh, Gerard Ledwich, 'Power Quality Enhancement using Custom Power Devices', Springer Science.

HVDC and FACTS for Transmission System (3-0-0) Code - UPEEE802

Prerequisites:

1. Power System Operation and Control.
2. Power Electronics.

Course Outcomes

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

1. Develop the knowledge of HVDC transmission and HVDC converters and the applicability and advantages of HVDC transmission over conventional AC transmission.
2. Formulate and solve mathematical problems related to rectifier and inverter control methods and learn about different control schemes as well as starting and stopping of DC-links.
3. Analyze the different harmonics generated by the converters and their variation with the change in firing angles.
4. Develop harmonic models and use the knowledge of circuit theory to develop filters and assess the requirement and type of protection for the filters.
5. Study and understand the nature of faults happening on both the AC and DC sides of the converters and formulate protection schemes for the same.
6. Review the existing HVDC systems along with MTDC systems and their controls, recognize the need to follow the advancements in both the existing systems and HVDC systems and determine the most economic coexistence of both.

Module 1: (10 Hours)

HVDC Transmission: HVDC Transmission system: Introduction, comparison of AC and DC systems, applications of DC transmission, types of DC links, Layout of HVDC Converter station and various equipment. HVDC Converters, analysis.

Module 2: (10 Hours)

FACTS Concepts: Reactive power control in electrical power transmission, principles of conventional reactive power compensators, flow of power in AC parallel paths, meshed systems, Controllable parameters

for Active & Reactive Power Control, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers.

Module 3: (10 Hours)

Static Shunt and Series Compensators: Shunt compensation - objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators - SVC, STATCOM, SVC and STATCOM comparison. Series compensation - objectives of series compensation, Thyristor switched series capacitors (TCSC), static series synchronous compensator (SSSC), power angle characteristics, and basic operating control schemes.

Text Books:

1. S. Kamakshiah & V. Kamaraju, "HVDC Transmission", TMH Education Private Ltd., 2011, New Delhi.
2. Narain G. Hingorani and L. Gyugyi, 'Understanding FACTS', IEEE Press.

Reference Books:

1. K. R. Padiyar, HVDC Power Transmissions Systems: Technology & Systems Interaction, New Age Publication, 2005
2. J. Arrillaga, Peter Pregrinu, High Voltage Direct Current Transmission.
3. Edward Wilson Kimbark, "Direct Current Transmission", Vol. I, Wiley interscience, New York, London, Sydney, 1971.
4. Colin Adamson and Hingorani N. G., "High Voltage Direct Current Power Transmission", Garraway Limited, London, 1960.

Advanced Electric Drives (3-0-0)

Code- UPEEE803

Prerequisites:

1. Power Electronics.
2. Control Systems.
3. Electrical Machines.
4. Electric Drives.

Course Outcomes

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

1. Acquire knowledge of modern electrical drive system components like VSI and CSIs with their advanced control techniques.
2. Model and analyze vector controlled three phase induction motor drives.
3. Model and analyze Direct Torque Control(DTC) of three phase induction motor drives.

4. Model and analyze vector control and DTC of three phase synchronous motor drives.
5. Acquire knowledge of controlling BLDC and PMSM motors.

Module 1: (10 Hours)

Power Converters for AC drives: PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.

Module 2: (10 Hours)

Induction motor drives: Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).

Module 3: (10 Hours)

Synchronous motor drives: Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

Permanent magnet motor drives: Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

Text/Reference Books:

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

Industrial Electrical Systems (3-0-0)

Code- UPEEE804

Prerequisites:

1. Basic Electrical Engineering.

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
2. Understand various components of industrial electrical systems.
3. Analyze and select the proper size of various electrical system components.

Module 1: (08 Hours)

Electrical System Components: LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

Module 2: (08 Hours)

Residential and Commercial Electrical Systems: Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Module 3: (06 Hours)

Illumination Systems: Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Module 4: (08 Hours)

Industrial Electrical Systems I: HT connection, industrial substation, Trans- former selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction - kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Text/Reference Books:

1. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age Inter- national, 2007.
3. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
4. Web site for IS Standards.
5. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

OPEN ELECTIVE SUBJECTS

Database Management Systems (3-0-0)

Prerequisites:

1. Programming for Problem Solving.

Module 1: (08 Hours)

Introduction to database Systems, advantages of database system over traditional file system, Basic concepts & Definitions, Database users, Database Language, Database System Architecture, Schemas, Sub Schemas, & Instances, database constraints, 3-level database architecture, Data Abstraction, Data Independence, Mappings, Structure, Components & functions of DBMS, Data models.

Module 2: (06 Hours)

Entity relationship model, Components of ER model, Mapping E-R model to Relational schema, Network and Object Oriented Data models, Storage Strategies: Detailed Storage Architecture, RAID.

Module 3: (08 Hours)

Relational Algebra, Tuple & Domain Relational Calculus, Relational Query Languages: SQL and QBE. Database Design:-Database development life cycle (DDLC), Automated design tools, Functional dependency and Decomposition, Join strategies, Dependency Preservation & lossless Design, Normalization, Normal forms:1NF, 2NF,3NF, and BCNF, Multi-valued Dependencies, 4NF & 5NF. Query processing and optimization: Evaluation of Relational Algebra Expressions, Query optimization, Query cost estimation.

Module 4: (08 Hours)

Transaction processing and concurrency control: Transaction concepts, properties of transaction, concurrency control, locking and Timestamp methods for concurrency control schemes. Database Recovery System, Types of Data Base failure & Types of Database Recovery, Recovery techniques. Fundamental concepts on Object-Oriented Database, Object relational database, distributed database, Parallel Database, Data warehousing & Data Mining and Big data and NoSQL.

Text Books:

1. Sudarshan, Korth: Database System Concepts, 6th edition, McGraw-Hill Education.

Reference Books:

1. Elmasari & Navathe: Fundamentals of Database System, Pearson Education.
2. Ramakrishnan: Database Management Systems, McGraw-Hill Education.
3. Andrew S. Tanenbaum: Modern Operating Systems, 3rd Edition, Pearson Education.
4. Terry Dawson, Olaf Kirch: Linux Network Administrator's Guide, 3rd Edition, O'Reilly Media.

Data Structures (3-0-0)

Prerequisites:

1. Programming for Problem Solving.

Module 1: (10 Hours)

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure.

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation - corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

Module 2: (10 Hours)

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations.

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree.

Module 3: (10 Hours)

Sorting and Searching: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.

Searching: Linear & binary search.

Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Text Books:

1. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.

Reference Books:

1. Algorithms, Data Structures, and Problem Solving with C++, Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company.
2. "How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.
3. Carrano, F. M., Data Abstraction and Problem Solving with C++, Benjamin Cummings, 1995.
4. Tenenbaum, A. M., Langsam, Augenstein, M. J., Data Structures Using C++, Prentice Hall, 1996.
5. Kruse, Tondo and Leung, Data Structures and Program Design in C, 2nd edition, Prentice-Hall, 1997.
6. Lipschuts S., Theory and Problems of Data Structures, Schaum's Series, 1986.

Internet of Things (3-0-0)

Prerequisites:

1. Programming for Problem Solving.

Module 1: (08 Hours)

Introduction to Internet of Things: Introduction-Definition & Characteristics of IoT, Physical Design of IoT, Things in IoT, Logical Design of IoT, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Architectures: Architectures for IoT, Elements of an IoT Architecture, Architectural design considerations IoT Enabling Technologies- Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, IoT Levels & Deployment.

Module 2: (06 Hours)

Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors, Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response, Environment- Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection, Energy- Smart Grids, Renew- able Energy Systems, Prognostics, Retail-Inventory Management, Smart Payments, Smart Vending Machines, Logistics-Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring, Remote Vehicle Diagnostics, Agriculture-Smart Irrigation, Green House Control, Industry -Machine Diagnosis & Prognosis Indoor Air Quality Monitoring ,Health & Lifestyle -Health & Fitness Monitoring, Wearable Electronics .

IoT and M2M M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking, Network Function Virtualization.

Module 3: (08 Hours)

Case Study on IoT System for Weather Monitoring: What is an IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interfaces - Serial, SPI, I2C, Programming with Python, Other IoT Devices- pcDuino, Beagle Bone Black, Cubieboard.

IoT application programming: Introduction to IoT device programming, IoT application development.

Module 4: (08 Hours)

IoT & Beyond: Use of Big Data and Visualization in IoT, Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data intensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet of Everything.

Data analytics for IoT: A framework for data-driven decision making, Descriptive, Predictive and Prescriptive Analytics, Business Intelligence and Artificial Intelligence, Importance of impact and open innovation in data-driven decision making.

Text Books:

1. Internet of Things, A Hands on Approach, by Arshdeep Bahga & Vijay Audisetti, University Press.

Reference Books:

1. The Internet of Things, by Michael Millen, Pearson.

Thermodynamics and Heat Transfer

Embedded Systems (3-0-0)

Prerequisites:

1. Microprocessors and Microcontrollers.

Course Outcomes

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

1. Suggest design approach using advanced controllers to real-life situations.
2. Design interfacing of the systems with other data handling / processing systems.
3. Appreciate engineering constraints like energy dissipation, data exchange speeds etc.
4. Implement simple embedded applications.

Module 1: (10 Hours)

Introduction to Embedded Systems- Classification, Challenges, design Issues, Von Neumann versus Harvard Architecture, RISC, CISC, Application Areas, Typical Embedded System- Core of Embedded System, Memory, Sensor, Actuator, Communication interface, Embedded Firmware, Other Components, Characteristics of Embedded Systems, Quality Attributes of Embedded Systems, Embedded Systems- Application and Domain Specific.

Module 2: (10 Hours)

PIC Architecture Introduction to PIC microcontrollers, PIC architecture, comparison of PIC with other CISC and RISC based systems and microprocessors, memory mapping, assembly language programming, addressing modes, instruction set. Overview of AVR Controllers and ARM Processors.

I/O Programming I/O ports, I/O bit manipulation programming, timers/ counters, programming to generate delay and wave form generation, I/O programming, LEDs, 7segment LED display, LCD and Keypad interfacing, Introduction to Proteus.

Module 3: (10 Hours)

Real Time Operating System for Embedded Systems- Tasks, Process, Threads, Multi Processing, Multi-Tasking, Task Communication, Task Synchronization, Deadlock, Scheduling Algorithms- Pre-emptive, Non Pre-emptive, Periodic, Aperiodic. How to choose an RTOS, Embedded Product Development Life Cycle.

Case Studies: Digital Camera, Washing Machine, Automotive, Smart Card

Text Books:

1. Shibu K. V., Introduction to Embedded Systems, Tata McGraw Hill, 2009
2. Chuck Hellebuyck, Programming PIC microcontrollers with PIC basic, Elsevier, 2003

Reference Books:

1. Peter Marwadel, Embedded System Design, Springer, 2014.
2. Frank Vahid and Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley, 2006.

VLSI (3-0-0)

Prerequisites:

1. Analog Electronics.
2. Digital System Design.

Course Outcomes

At the end of the course the students will be able to:

1. Interpret the submicron issues in VLSI Design.
2. Design different CMOS circuits using various logic families along with their circuit layout.
3. Analyze parasitic effects, switching delays, power dissipation issues in VLSI designs.
4. Implement VLSI IC design using EDA tools.

Module 1: (10 Hours)

Basic MOSFET Characteristics -The MOS Threshold Voltage, Body Bias, CV Characteristics, Scaling, Small-Device Effects-Threshold Voltage Modifications, Mobility Variations, Hot Electrons, Small Device Model, Basic Circuit and DC Operation (CMOS) - DC Characteristics, Noise Margins, Transistor as a switch.

Module 2: (10 Hours)

Inverter Switching Characteristics-Switching Intervals, High-to-Low Time, Low- to-High Time, Maximum Switching Frequency, Transient Effects on the VTC, RC Modelling, Propagation Delay, Use of the Step-Input Waveform, Output Capacitance, Inverter Design- DC Design, Transient Design, Power Dissipation, Driving Large Capacitive Loads, Pass Transistor Logic, Pseudo-nMOS Logic Gates- Complex Logic in Pseudo-nMOS, Simplified XNOR Gate, Transmission Gate, Sequential Circuit Design, CMOS Differential Logic Families, Dynamic Logic, Domino Logic, NORA, Zipper Logic.

Module 3: (10 Hours)

Integrated Circuit Layout: Design Rules, Parasitics, Delay: RC Delay model, linear delay model, logical path efforts, Power, interconnect and Robustness in CMOS circuit layout, Issues in Chip Design-On-Chip Interconnects-Line Parasitics, Modelling of the Interconnect Line, Clock Distribution, Coupling Capacitors

and Crosstalk, Input and Output Circuits- Networks, Output Circuits, Transmission Lines- Ideal Transmission Line Analysis, Reflections and Matching, Introduction to VHDL/ Verilog.

Text Books:

1. J. P. Uyemura, CMOS Logic Circuit Design, Kluwer Academic Publishers 2001.
2. Sung-Mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw-Hill Education, 2003.

Reference Books:

1. N. H. E. Weste and D. M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.
2. J. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson Education India 2016, ISBN-13: 9788120322578.
3. C. Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley, 1979.

Fluid Mechanics and Hydraulic Machinery

Complex Analysis and Partial Differential Equations (3-0-0)

Prerequisites:

1. Mathematics-I.
2. Mathematics-II.

Course Outcomes

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

1. Explain the fundamental concepts of partial differential equations and their role in modern mathematics and applied contexts
2. Demonstrate accurate and efficient use complex analysis,
3. Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from partial differential equations and complex analysis,
4. Apply complex analysis to diverse situations in physics, engineering and other mathematical contexts.

Module 1: (10 Hours)

Partial differential equation of first order, Linear partial differential equation, Non-linear partial differential equation, Homogeneous and non-homogeneous partial differential equation with constant co-efficient, Cauchy type, Monge's method, Second order partial differential equation. The vibrating string, the wave equation and its solution, the heat equation and its solution, Two-dimensional wave equation and its solution, Laplace equation in polar, cylindrical and spherical coordinates, potential.

Module 2: (10 Hours)

Complex Analysis: Analytic function, Cauchy-Riemann equations, Laplace equation, Conformal mapping, Complex integration: Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions.

Module 3: (10 Hours)

Power Series, Taylor's series, Laurent's series, Singularities and zeros, Residue integration method, evaluation of real integrals.

Text Books:

1. E. Kreyszig, "Advanced Engineering Mathematics", Eighth Edition, Wiley India Reading Chapters: 11,12(except 12.10),13,14,15
2. B.V. Ramana, "Higher Engineering Mathematics", McGraw Hill Education, 2008 Reading chapter: 18

Reference Books:

1. E. B. Saff, A. D. Snider, "Fundamental of Complex Analysis", Third Edition, Pearson Education, New Delhi
2. P. V. O'Neil, "Advanced Engineering Mathematics", CENGAGE Learning, New Delhi

Computer Networks (3-0-0)

Prerequisites:

1. Basic Computers.

Module 1: (10 Hours)

Overview of Data Communication Networks, Protocols and standards, OSI Reference model, TCP/IP Protocol.

Physical Layer: Analog Signals, Digital Signals, Data Rate Limits, Transmission Impairment, Data rate limit, Digital Transmission: Digital-to-Digital conversion, Analog-to-Digital conversion, Transmission modes, Analog Transmission: Digital-to-Analog conversion, Analog-to-Analog conversion, Multiplexing: Frequency Division Multiplexing (FDM), Wave Division Multiplexing (WDM), Time Division Multiplexing (TDM), Transmission Media: Guided Media (Twisted-Pair Cable, Coaxial Cable and Fiber-Optic Cable) and unguided media (wireless).

Module 2: (08 Hours)

Error Detection and correction: Types of Errors, Error Detection mechanism (Linear codes, CRC, Checksum), Error Correction mechanism: Hamming Encoding.

Data Link Control and Protocols: Flow and Error Control, Stop-and-Wait ARQ, Go-Back-N ARQ, Selective Repeat ARQ, HDLC and Point-to-Point Protocol.

Multiple Access: Random Access (ALOHA, CSMA, CSMA/CD, CSMA/CA), Controlled Access (Polling, Reservation, Token Passing), Channelization (FDMA, TDMA, CDMA).

Wired LANs (Ethernet): Traditional Ethernet, Fast Ethernet, Gigabit Ethernet.

Module 3: (06 Hours)

Wireless LANs: IEEE 802.11 and Bluetooth.

Network Layer: IPV4 addresses, IPV6 addresses, Internet Protocol: Internet working, IPV4 datagram, IPV6 packet format and advantages. Network Layer Protocols: ARP, RARP, IGMP and ICMP. Routing: Unicast Routing Protocols and Multicast Routing Protocols.

Transport Layer: Process to Process Delivery, User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).

Module 4: (06 Hours)

Domain Name System (DNS): Name Space, Domain Name Space, DNS in Internet, Resolution and Dynamic Domain Name System (DDNS), Remote logging, Electronic Mail (SMTP) and file transfer (FTP), WWW: Architecture & Web document, HTTP: Transaction & Persistent vs. Non-persistent connection.

Text Books:

1. Computer Networks, A. S. Tannenbum, D. Wetherall, Prentice Hall, Imprint of Pearson.
2. Data and Computer Communications, William Stallings, Prentice Hall, Imprint of Pearson.

Reference Books:

1. Data Communication and Networks, Bhushan Trivedi, Oxford University Press
2. Computer Networks A System Approach, Larry L, Peterson and Bruce S. Davie, Elsevier.
3. Computer Networks, Natalia Olifer, Victor Olifer, Willey India.

Big Data Analytics (3-0-0)

Prerequisites:

1. Programming for Problem Solving.
2. Data Structures.

Module 1: (10 Hours)

Introduction: Big Data Overview, The rising and importance of data sciences, Big data analytics in industry verticals.

Hadoop Architecture: Hadoop Architecture, Hadoop ecosystem components, Hadoop Storage: HDFS, Hadoop Processing: Map Reduce Framework, Hadoop Server Roles.

Module 2: (10 Hours)

Data Analytics Lifecycle and methodology: Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, Communicating results, Deployment, Data exploration & preprocessing.

Data Analytics - Theory & Methods: Measures and evaluation, Supervised learning, Linear/Logistic regression, Decision trees, Bayes, Unsupervised learning, K-means clustering, Association rules, Unstructured Data Analytics, Technologies & tools, Text mining, Web mining.

Module 3: (10 Hours)

The Endgame: Operationalizing an Analytics project, Data Visualization Techniques, Creating final deliverables.

Text/Reference Books:

1. Hadoop: The Definitive Guide by Tom White.
2. Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph by David Loshin.
3. Machine Learning by Tom M. Mitchell.

Digital Image Processing (3-0-0)

Prerequisites:

1. Signals and systems.
2. Digital Signal Processing.

Course Outcomes

On successful completion of the course, students should be able to:

1. Review the fundamental concepts of a digital image processing system.
2. Analyze images in the frequency domain using various transforms.
3. Evaluate the techniques for image enhancement and image restoration.
4. Categorize various compression techniques.
5. Interpret Image compression standards.
6. Interpret image segmentation and representation techniques.

Module 1: (10 Hours)

Digital Image Fundamentals and Transforms: Elements of visual perception, Image sampling and quantization Basic relationship between pixels, Basic geometric transformations, Introduction to Fourier Transform and DFT, Properties of 2D Fourier Transform, FFT, Separable Image Transforms, Walsh-Hadamard, Discrete Cosine Transform, Haar, Slant - Karhunen - Loeve transforms.

Image Enhancement Techniques: Spatial Domain methods: Basic grey level transformation, Histogram equalization, Image subtraction, Image averaging, Spatial filtering: Smoothing, sharpening filters, Laplacian filters, Frequency domain filters: Smoothing, Sharpening filters, Homomorphic filtering.

Image Restoration: Model of Image Degradation/restoration process, Noise models, Inverse filtering, Least mean square filtering, Constrained least mean square filtering, Blind image restoration, Pseudo inverse, Singular value decom- position.

Module 2: (10 Hours)

Image Segmentation: Point, Line, Edge detection, Thresholding, Region Based segmentation, Hough Transform.

Image Compression: Lossy and lossless compression schemes, prediction based compression schemes, vector quantization, sub-band encoding schemes, JPEG compression standard, Fractal compression scheme, Wavelet compression scheme.

Module 3: (10 Hours)

Color Image Processing: Color Representation, Laws of color matching, chromaticity diagram, color enhancement, color image segmentation, color edge detection, color demosaicing.

Morphological Image Processing: Dilation, Erosion, Duality, Opening, Closing, Hit-or-Miss Transformation, Basic morphological algorithm.

Text Books:

1. Rafael C Gonzalez, Richard E Woods, Digital Image Processing, 2nd Edition, Pearson Education 2003.
2. A. K. Jain, Fundamentals of Digital Image Processing, PHI.

Reference Books:

1. William K Pratt, Digital Image Processing, John Wiley Publishers.
2. Millman Sonka, Vaclav Hlavac, Image Processing Analysis and Machine Vision, Thompson Learning (1999).

Artificial Intelligence (3-0-0)

Prerequisites:

1. Basic Mathematics.

Module 1: (10 Hours)

Introduction to AI and intelligent agents. Problem Solving: Solving Problems by Searching, heuristic search techniques, constraint satisfaction problems, stochastic search methods. Game Playing: minimax, alpha-beta pruning.

Module 2: (10 Hours)

Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic. Planning, partial order planning.

Module 3: (10 Hours)

Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks. Learning: Overview of different forms of learning, Learning Decision Trees, Neural Networks Introduction to Natural Language Processing.

Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice-Hall.
2. Nils J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan-Kaufmann.
3. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Prentice Hall of India, Delhi, 2001.

Reference Books:

1. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill, Delhi, 2001.
2. George F Luger, "Artificial Intelligence, structures and strategies for complex problem solving", Pearson Education Delhi, 2001.

Soft Computing (3-0-0)

Prerequisites:

1. Basic Mathematics.

Module 1: (10 Hours)

Introduction to Soft Computing: Concept of computing systems, "Soft" computing versus "Hard" computing, Characteristics of Soft computing, some applications of Soft computing techniques Artificial Neural Networks, Biological neurons and its working, Simulation of biological neurons to problem solving, Different ANNs architectures, Training techniques for ANNs, Applications of ANNs to solve some real life problems.

Module 2: (10 Hours)

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

Module 3: (10 Hours)

Genetic Algorithms: Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, etc., Solving single-objective optimization problems using Gas, Multi-objective Optimization Problem Solving, Concept of multi-objective optimization problems (MOOPs) and issues of solving them, Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs, Some applications with MOEAs.

Text/Reference Books:

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S. Rajasekaran, G. A. Vijayalakshami, PHI.

2. Chin Teng Lin, C. S. George Lee, Neuro-Fuzzy Systems, PHI.
3. Tomthy Ross, Fuzzy Logic and Engineering Application, TMH.
4. Kishan Mehrotra, Elements of Artificial Neural Network, MIT Press.
5. E. Goldberg, Genetic Algorithms: Search and Optimization, Addison- Wesley.

Advanced Signal Processing (3-0-0)

Prerequisites:

1. Signals & Systems.
2. Electrical Circuit Analysis.

Course Outcomes

Upon completion of this course, students should be able to:

1. Understand the terminology that are used in the wavelets literature.
2. Explain the concepts, theory, and algorithms behind wavelets from an interdisciplinary perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multi resolution analysis (computer vision).
3. Understand how to use the modern signal processing tools using signal spaces, bases, operators and series expansions.
4. Apply wavelets, filter banks, and multi-resolution techniques to a problem at hand, and justify why wavelets provide the right tool.
5. Think critically, ask questions, and apply problem-solving techniques.

Module 1: (04 Hours)

Introduction to time frequency analysis; Fourier series, Orthogonality, Orthonormality and the method of finding the Fourier coefficients Complex Fourier series, Orthogonality of complex exponential bases, Mathematical preliminaries for continuous and discrete Fourier transform, limitations of Fourier domain signal processing.

Module 2: (08 Hours)

Signal representation with continuous and discrete STFT, concept of time- frequency resolution, Resolution problem associated with STFT, Heisenberg's Uncertainty principle and time frequency tiling, The origins of wavelets, Wavelets and other wavelet like transforms, History of wavelet from Morlet to Daubechies via Mallat, Different communities and family of wavelets, Different families of wavelets within wavelet communities, Properties and mathematical conditions of wavelet functions. Some popular wavelet functions.

Module 3: (06 Hours)

Wavelet transform-A first level introduction, Continuous time-frequency representation of signals, Properties of wavelets used in continuous wavelet transform, Continuous versus discrete wavelet transform, Discrete wavelet transform, tiling of the time-frequency plane and wave-packet analysis.

Module 4: (12 Hours)

Signal decomposition (Analysis), Relation with filter banks, Frequency response, Signal reconstruction: Synthesis from coarse scale to fine scale, Up-sampling and filtering, Perfect reconstruction filters, QMF conditions, Computing initial s_{j+1} coefficients, Concepts of Multi-Resolution Analysis (MRA) and Multi-rate signal processing, Filter bank theory.

Application of wavelet theory in to signal denoising, Power Signal Processing, image compression, digital communication, transient and fault detection in power system. Commercial applications in which wavelet approach is established.

Text Books:

1. Y. T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993.
2. K. P. Soman, K. I. Ramachandran, N. G. Resmi, "Insight into Wavelets: From Theory to Practice, (Third Edition)", PHI Learning Pvt. Ltd., 2010.
3. M. Vetterli and J. Kovacevic, "Wavelets and Sub-Band Coding", Prentice Hall, 1995.

Reference Books:

1. I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
2. Gerald Kaiser, A Friendly Guide to Wavelets, Birkhauser, New York, 1995.
3. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, New Jersey, 1993.
4. S. Mallat, "A Wavelet Tour of Signal Processing," Academic Press, Second Edition, 1999.
5. G. Strang and T. Q. Nguyen, "Wavelets and Filter Banks," Wellesley- Cambridge Press, Revised Edition, 1998.
6. B. Boashash, Time-Frequency signal analysis, In S. Haykin, (editor), Advanced Spectral Analysis, Prentice Hall, New Jersey, 1991.

Reference Links:

1. <http://users.rowan.edu/~polikar/WAVELETS/WTtutorial.html>
2. <http://www.wavelet.org/>
3. <http://www.math.hawaii.edu/~dave/Web/Amara's%20Wavelet%20Page.htm>

Biomedical Instrumentation (3-0-0)

Prerequisites:

1. Basic circuit theory.
2. Differential Equations.
3. Basic time/frequency domain concepts.

Course Outcomes

At the end of this course student will be able to:

1. Comprehend theory based understanding of the physical sciences and the engineering fundamentals applicable to the engineering discipline.
2. Have In-depth understanding of specialist bodies of knowledge within the engineering discipline.
3. Application of established engineering methods to complex engineering problem solving.
4. Application of systematic engineering synthesis and design processes.

Module 1: (10 Hours)

Introduction to Bioengineering, Biochemical Engineering, Biomedical Engineering, Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, use of microprocessors in medical instruments, PC based medical Instruments, general constraints in design of medical Instrumentation system & Regulation of Medical devices.

Bio-electrical Signals & Electrodes: Origin of Bio-electric Signals, Electrocardiogram, Electroencephalogram, Electromyogram, Electrode-Tissue Interface, Polarization, Skin Contact Impedance, Motion Artifacts.

Module 2: (10 Hours)

Electrodes for ECG: Limb Electrode, Floating Electrodes, Pre jelled disposable Electrodes, Electrodes for EEG, Electrodes for EMG.

Physiological Transducers: Introduction to Transducers, Classification of Transducers, Performance characteristics of Transducers, Displacement, Position and flow and pressure Transducers.

Strain gauge pressure transducers, Thermocouples, Electrical Resistance Thermometer, The mister, Photovoltaic transducers, Photo emissive Cells & Bio sensors or Biochemical Sensor.

Module 3: (10 Hours)

Recording Systems: Basic Recording systems, General considerations for Signal conditioners, Pre amplifiers, Differential Amplifier, Isolation Amplifier, Electro- static and Electromagnetic Coupling to AC Signals, Proper Grounding (Com- mon Impedance Coupling)

Text Books:

1. R. S. Khandpur, Hand Book of Biomedical Instrumentation, 2nd Ed, Tata McGraw Hill, 2003.
2. Michael M. Domach, Introduction to Biomedical Engineering, Pearson Education Inc., 2004.

Satellite Communication System (3-0-0)

Prerequisites:

1. Basics of Analog and Digital Communication.

Course Outcomes

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

1. Define orbital mechanics and launching methodologies of satellites.
2. Analyze the satellite subsystems.
3. Design link power budget for satellites.
4. Compare different multiple access techniques for satellite communications.

Module 1: (08 Hours)

Satellite Orbits: Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non-Geo-stationary orbits - Look Angle Determination- Limits of visibility Eclipse-Sub satellite point -Sun transit Outage-Launching Procedures - launch vehicles and propulsion.

Module 2: (12 Hours)

Space Segment and Satellite Link Design: Spacecraft Technology: Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command.

Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions.

Module 3: (10 Hours)

Satellite Access: Modulation and Multiplexing: Voice, Data, Video, Analog-digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, Assignment Methods, Spread Spectrum communication.

Satellite Applications: INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. Direct Broadcast satellites (DBS)- Direct to home Broadcast (DTH).

Text Books:

1. Timothy Pratt et. al., "Satellite Communications", Wiley India, 2nd edition, 2010.
2. S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011.

Reference Books:

1. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.
2. Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008.

Machine Learning (3-0-0)

Prerequisites:

1. Basic Mathematics.
2. Artificial Intelligence/Soft Computing.

Module 1: (08 Hours)

Algorithmic models of learning. Learning classifiers, functions, relations, grammars, probabilistic models, value functions, behaviours and programs from experience. Bayesian, maximum a posteriori, and minimum description length frameworks.

Module 2: (08 Hours)

Parameter estimation, sufficient statistics, decision trees, neural networks, support vector machines, Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, probabilistic relational models, association rules, nearest neighbor classifiers, locally weighted regression, ensemble classifiers.

Module 3: (06 Hours)

Computational learning theory, mistake bound analysis, sample complexity analysis, VC dimension, Occam learning, accuracy and confidence boosting. Dimensionality reduction, feature selection and visualization. Clustering, mixture models, k-means clustering, hierarchical clustering, distributional clustering.

Module 4: (08 Hours)

Reinforcement learning; Learning from heterogeneous, distributed, data and knowledge. Selected applications in data mining, automated knowledge acquisition, pattern recognition, program synthesis, text and language processing, internet-based information systems, human-computer interaction, semantic web, and bio-informatics and computational biology.

Text Books:

1. Bishop, C. (2006). Pattern Recognition and Machine Learning. Berlin: Springer-Verlag.

Reference Books:

1. Baldi, P. and Brunak, S. (2002), Bioinformatics: A Machine Learning Approach, Cambridge, MA: MIT Press.
2. Bishop, C. M., Neural Networks for Pattern Recognition, New York: Oxford University Press (1995).
3. Chakrabarti, S. (2003), Mining the Web, Morgan Kaufmann.
4. Cohen, P. R. (1995), Empirical Methods in Artificial Intelligence, Cambridge, MA: MIT Press.

5. Cowell, R. G., Dawid, A. P., Lauritzen, S. L., and Spiegelhalter, D. J. (1999), Graphical Models and Expert Systems, Berlin: Springer.
6. Cristianini, N. and Shawe-Taylor, J. (2000), An Introduction to Support Vector Machines, London: Cambridge University Press.

Optimization in Engineering (3-0-0)

Prerequisites:

1. Mathematics.

Course Outcomes

On successful completion of this course, the students will be able to:

1. Understand and use methods for constrained and unconstrained Optimization.
2. Understand the mathematical background to solve optimization problems.
3. Formulate and solve non-linear programming problems from real field data.
4. Demonstrate the ability to choose and justify optimization techniques that are appropriate for solving realistic engineering problems.

Module 1: (10 Hours)

Idea of Engineering optimization problems, Classification of optimization algorithms, Modelling of problems and principle of modelling. Linear Programming: Formulation of LPP, Graphical solution, Simplex method, Big M method, Re-vised simplex method, Duality theory and its application, Dual simplex method, Sensitivity analysis in linear programming.

Module 2: (10 Hours)

Transportation problems: Finding an initial basic feasible solution by North-west Corner rule, least cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. Assignment problems: Hungarian method for solution of Assignment problems.

Integer Programming: Branch and Bound algorithm for solution of Integer Programming problems.

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, Multiple server, Finite sources.

Module 3: (10 Hours)

Introduction to non-linear programming, Unconstrained optimization: Fibonacci and Golden Section Search method, Steepest Descent Method, Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method, Constrained optimization with inequality constraint: Kuhn-Tucker condition, Primal-Dual Method, Quadratic programming.

Text Books:

1. Ravindran, D. T. Philips, J. Solberg," Operations Research- Principle and Practice", Second edition, Wiley India Pvt Ltd.
2. Kalyanmoy Deb," Optimization for Engineering Design", PHI Learning Pvt Ltd.

Reference Books:

1. V. Krishnamurthy, V. P. Mainra and J. L. Arora," An introduction to Linear Algebra by V. Krishnamurthy", East West Publication.
2. M. Artin, Algebra, Prentice-Hall of India.
3. Hoffman and Kunze," Linear Algebra", 2nd ed., PHI.
4. H. A. Taha, A. M. Natarajan, P. Balasubramanie, A. Tamilarasi," Operations Research", Eighth Edition, Pearson Education.
5. F. S. Hiller, G. J. Lieberman," Operations Research", Eighth Edition, Tata McGraw Hill.
6. P. K. Gupta, D. S. Hira," Operations Research", S. Chand and Company Ltd.
7. Kanti Swarup, P. K. Gupta, Man Mohan," Operations Research", Sultan Chand and Sons.

Robotics (3-0-0)

Prerequisites:

1. Engineering Mathematics.

Course Outcomes

On successful completion of this course the students should be able to:

1. Have an awareness of basics of robotics.
2. Perform robot programming.
3. Appreciate the applications of robotics and be able to apply economic measures to justify advantages of robots in industry.

Module 1: (10 Hours)

Fundamentals of Robotics: Evolution of robots and robotics, Definition of industrial robot, Laws of Robotics, Classification, Robot Anatomy, Work volume and work envelope, Human arm characteristics, Design and control issues, Manipulation and control, Resolution; accuracy and repeatability, Robot configuration, Economic and social issues, Present and future application.

Mathematical modeling of a robot: Mapping between frames, Description of objects in space, Transformation of vectors. Direct Kinematic model: Mechanical Structure and notations, Description of links and joints, Kinematic modeling of the manipulator, Denavit- Hartenberg Notation, Kinematic relationship between adjacent links, Manipulator Transformation matrix.

Module 2: (10 Hours)

Inverse Kinematics: Manipulator workspace, Solvable of inverse kinematic model, Manipulator Jacobian, Jacobian inverse, Jacobian singularity, Static analysis.

Dynamic modeling: Lagrangian mechanics, 2D- Dynamic model, Lagrange- Euler formulation, Newton-Euler formulation.

Robot Sensors and Actuators: Internal and external sensors, force sensors, Thermocouples, Performance characteristic of a robot. Hydraulic and pneumatic actuators, Electrical actuators, Brushless permanent magnet DC motor, Servomotor, Stepper motor, Micro actuator, Micro gripper, Micro motor, Drive selection.

Module 3: (10 Hours)

Robot Programming: Methods - Languages - Capabilities and limitation - Artificial intelligence - Knowledge representation -Search techniques in AI and Robotics.

Trajectory Planning: Definition and planning tasks, Joint space planning, Cartesian space planning.

Applications of Robotics: Capabilities of robots, Material handling, Machine loading and unloading, Robot assembly, Inspection, Welding, Obstacle avoidance.

Text Books:

1. Robotics and Control, R. K. Mittal and I. J. Nagrath, Tata McGraw Hill.
2. Introduction to Robotics: Mechanics and control, John J Craig, PHI.
3. Robotics Technology and Flexible Automation, S. R. Deb and S. Deb, TMH.
4. Introduction to Robotics, S. K. Saha, Tata McGraw Hill.

Reference Books:

1. Robotic Engineering: An Integrated Approach, R.D. Klafter and T. A. Chmielewski.
2. Industrial Robotics Technology -Programming and Applications, Mikell P. Groover, Mitchell Weiss, McGraw Hill International Edition.
3. Foundation of Robotics: Analysis and Control, Yoshikawa, Prentice Hall of India.
4. Robotics: Control, Sensing, Vision and Intelligence, K. S. Fu, R. C. Gonzalez and C. S. G. Lee, McGraw Hill.
5. Robot Dynamics and Control, M. W. Spong and M. Vidyasagar, Wiley India.
6. Industrial Robotics Technology, programming and application, M. P. Groover, TMH.
7. Introduction to Robotics: Analysis, Systems, Applications, S. B. Niku, PHI.
8. Robotics: Fundamental Concepts and Analysis, A. Ghosal, Oxford University Press.
9. Fundamentals of Robotics: Analysis and Control, R. J. Schilling, PHI.
10. Robot Technology: Fundamentals: J. G. Keramas, Cengage Learning.

Power Station Engineering and Economy (3-0-0)

Prerequisites:

1. Basic Electrical Engineering.

Course Outcomes

At the end of the course, the student will be able to:

1. Know the various components and working of hydel power stations.
2. Learn about the various components and working of nuclear power stations.
3. Know the various components and working of thermal power stations.
4. Have an idea about the generation cost associated with different generating stations
5. Learn about economic scheduling.

Module 1: (06 Hours)

Introduction to different sources of energy and general discussion on their application to generation: Indian Energy Scenario. Load duration curves, Load Factor, Capacity Factor, Reserve Factor, Demand Factor, Diversity Factor, Plant Use Factor, Base Load, Intermediate Load and Peak Load Plants.

Nuclear Power Station: Introduction to fission & fusion, reactor construction, controlled chain reaction, operational control of reactors, Brief study of various types of reactors (Boiling water, pressurized water, heavy water, breeder), Location and layout of nuclear power plant

Module 2: (10 Hours)

Hydel Power Station: Selection of site for hydro-electric power plant. Hydrology: Hydrological cycle, precipitation, run-off and its measurement, hydro- graph, flow duration and mass curves, Estimation of amount stored by a dam across the river, Storage and Pondage.

Turbines: Operational principle of Kaplan and Francis Turbine and Pelton wheel, Speed and Pressure Regulation, Work done, efficiency.

Essential Elements of a Hydro-electric Power Plant: Catchment area, Reservoir, Dam, Head Gate, Spillways, Pen stock, Surge Tanks, Scroll case, Draft tubes and Tail Race, Power House, Classification of Hydroelectric Power Plants. Governors, Plant auxiliaries

Module 3: (10 Hours)

Thermal Power Station: Selection of site for thermal power plant. Over- all Block Diagram indicating the air circuit, coal and ash circuit, water and steam circuit, various types of steam turbines, ash and coal handling system, High Pressure and High capacity water tube boilers, Economizer, Superheaters, De-Superheater, Re-heater, Air Pre-heater. (Draft System: Natural, Induced Forced and Balance Draft, PA fan, FD fan, ID fan, Chimney.

Condensers, Feed water heaters, Evaporators, Make-up water, Bleeding of steam, Cooling water system. Electrostatic Precipitator: Basic working Principle and constructional details, Governors, Plant auxiliaries.

Module 4: (04 Hours)

Economics of Power Generation: Construction costs, Fixed cost and Depreciation, Fuel cost, Economic scheduling principle, Annual Operating Costs, Effect of Load Factor on cost per kWh.

Text/Reference Books:

1. P. K. Nag, "Power Plant Engineering", 3rd Edition, Tata McGraw Hill Publication
2. Bernhardt G. A. Skrotzki, William A. Vopat, 'Power Station Engineering and Economy', 2nd Edition, Tata McGraw Hill Publication
3. M. V. Deshpande, Elements of Electrical Power Station Design, PHI
4. Arora & Domkundwar, 'A Course in Power Plant Engineering', Dhanpat Rai and sons.
5. R. K. Rajput, 'A Text Book of Power Plant Engineering', 3rd Edition, Laxmi Publishing.