
# B. Tech Electrical and Electronics Engineering Curriculum

(For the students admitted during AY 2018-22)

**Semester I**

| **Subject Code** | **Subject Name** | **L-T-P** | Credits |
|---|---|---|---|
| EGL 101 | Introduction to Communication | 3-0-0 | 3 |
| PHY 101 | Introduction to Classical Mechanics | 2-0-0 | 2 |
| PHY 101 | Introduction to Classical Mechanics Lab | 0-0-2 | 1 |
| ENG 111 | Basic Electronics | 3-0-0 | 3 |
| ENG 111 | Basic Electronics Lab | 0-0-2 | 1 |
| MAT111 | Single Variable Calculus | 3-0-0 | 3 |
| BIO 101 | Introduction to Biology | 2-0-2 | 3 |
| CSE 102 | Introduction to Computer Science and Programming | 3-0-0 | 3 |
| CSE 102 | Introduction to Computer Science and Programming Lab | 0-0-2 | 1 |
| CDC 101 | CDC-1 | 1-0-0 | 1 |
| | | Total | 21 |

**Semester II**

| **Subject Code** | **Subject Name** | **L-T-P** | **Credits** |
|---|---|---|---|
| CDC 102 | CDC-2 | 1-0-0 | 1 |
| CHE 101 | Principles of Chemistry | 2-0-2 | 3 |
| PHY | Electricity and Magnetism | 2-0-2 | 3 |
| ECO | Economics | 3-0-0 | 3 |
| CSE223 | Data Structures and Algorithms using C | 3-0-2 | 4 |
| MAT 121 | Multi Variable Calculus | 3-0-0 | 3 |
| EE 101 | Introduction of Electrical Engineering | 2-1-2 | 4 |
| | | Total | 21 |

**Semester III**

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| EE 201 | Electrical and Electronics Measurement | 2-1-0 | 3 |
| MAT 131 | Differential Equations | 3-0-0 | 3 |
| EE 202 | Electrical Circuit Analysis | 2-1-0 | 3 |
| OE | Open Elective I | 3-0-2 | 4 |
| OE | Open Elective II | 3-0-2 | 4 |
| ENG 101 | Fundamentals of Mechanical Engineering | 3-0-0 | 3 |
| | CDC-3/CCC-1 | 1-0-0 | 1 |
| | | Total | 21 |

**Semester IV**

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| | CDC-4/CCC-2 | 1-0-0 | 1 |
| HS | Humanities/Social Studies Elective | 3-0-0 | 3 |
| MAT | Linear Algebra | 3-0-0 | 3 |
| OE | Open Elective III | 3-0-2 | 4 |
| EEE 203 | Control Systems Design | 2-1-0 | 3 |
| EE | UROP | 0-0-6 | 3 |
| EE 204 | Electrical Machine -I | 3-0-0 | 3 |
| EE 204 | Electrical Machine -I Lab | 0-0-2 | 1 |
| ME 211 | SolidWorks (Engineering Graphics) | 0-0-2 | 1 |
| | | Total | 22 |

**Semester V**

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| EE 301 | Electrical Machine -II | 3-0-0 | 3 |
| EE 301 | Electrical Machine -II Lab | 0-0-2 | 1 |
| OE | Open Elective -IV | 3-0-0 | 3 |
| OE | Open Elective- V | 3-0-2 | 4 |
| EE 304 | Power System-I | 3-0-0 | 3 |
| EE 304 | Power System-I Lab | 0-0-2 | 1 |
| EE 305 | Advance Control Systems Design | 2-0-0 | 2 |
| EE 305 | Advance Control Systems Design Lab | 0-0-2 | 1 |
| EE 303 | Technical Elective-I | 3-0-0 | 3 |
| | CDC-5/CCC-3 | | |
| | | Total | 21 |

**Semester VI**

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| EEE 306 | Power System-II | 3-0-0 | 3 |
| EEE 306 | Power System-II Lab | 0-0-2 | 1 |
| EEE 307 | Technical Elective-II | 3-0-0 | 3 |
| EEE 308 | Power Electronics | 3-0-0 | 3 |
| EEE 308 | Power Electronics Lab | 0-0-2 | 1 |
| EEE 309 | Electrical Machine -III | 3-0-0 | 3 |
| EEE 309 | Electrical Machine -III Lab | 0-0-2 | 1 |
| ENG 321 | Multi-Disciplinary Design Project | 0-0-6 | 3 |
| OE | Open Elective -VI | 3-0-0 | 3 |
| | CDC-6/CCC-4 | Total | 21 |

**Semester VII**

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| EE 402 | Technical Elective-III | 3-0-0 | 3 |
| TE | Technical Elective-IV | 3-0-0 | 4 |
| TE | Technical Elective-V | 3-0-0 | 3 |
| EE 403 | Power System-III | 3-0-0 | 3 |
| EE 403 | Power System-III Lab | 0-0-1 | 1 |
| OE | Open Elective -VII | 3-0-0 | 3 |
| EEE 404 | High Voltage Engineering | 3-0-0 | 3 |
| EEE 404 | High Voltage Engineering Lab | 0-0-2 | 1 |
| | | Total | 21 |

**Semester VIII**

| Subject Code | Subject Name | L-T-P | Credits |
|---|---|---|---|
| EE | Project | 0-0-18 | 9 |

**SEMESTER – I**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EGL 101 | Introduction to Communication | C | 3 | 0 | 0 | 3 |

**Course Objective:** Introduction to Communication is designed to help students with the principles and practice of effective oral communication skills. This course will help students through formal and informal speaking activities. Strategies for effective communication in social, business, and professional situations are examined. In all speaking assignments, articulation and the best way to frame ideas will be covered. The course objectives are for students to demonstrate an understanding of the value of rhetorical speaking skills; Paraphrase and cite research correctly; write and speak well-developed, clear, unified ideas with appropriate college-level language choices; Demonstrate a growing understanding of critical thinking in speaking, writing and in public situations.

**UNIT I: Rhetoric and Public Speaking**

Rhetoric, Critical Thinking and Public Speaking; Thinking Outside the Box; How to Deliver a Speech; Fundamentals of Persuasion.

**UNIT II: Nonverbal Communication**

Nonverbal Communication; Spatial distance, eye contact and appearances; How nonverbal communication is more important than words.

**UNIT III: Communication and the Media**

Persuasion and the media; Radio, television, film, social media and the internet; How the media sells ideas, images, products and life styles; Fundamentals of Informative/Scientific Speeches and Research; The Heart of the Speech – Powerful Narratives; The Power of Narrative.

**UNIT IV: Small Group Communication**

Small group communication; Leadership, conflict and persuasion in groups; The importance of small groups in business; Dr. A. Fisher's Fundamentals of Small Groups; Group Problem Solving; Learning to say no – don't say you will when you won't, don't say yes and then don't do it, be true to your word.

**UNIT V: Persuasion, Ideology and Media Bias.**

Advanced Rhetoric; Ideology; Persuasive Fallacies; How to Construct a Persuasive Speech; How to Present Scientific Data in a Speech; Unmasking Media Bias and Ideology; Full circle – the dangers of rhetoric and ideology.

**Books of Study**

1. Communication: Principles for a Lifetime. Beebe, Beebe and Ivy, 6th Edition, Pearson Publishing.

**Books of Reference**


1. Qualitative Communication Research Methods (2011) Bryan C. Taylor and Thomas R. Lindlof. Sage Publications, New Delhi, India, 3rd Edition.
2. The Fundamentals of Small Group Communication (2008) Scott A. Myers and Carolyn M. Anderson. Sage Publications, New Delhi, India.

**SEMESTER – I**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| MAT 112 | Single Variable Calculus | Core | 3 | 0 | 0 | 3 |

Course description: This course is an introduction to Single Variable Calculus to all engineering students. The objective is to equip the students with the knowledge of calculus and its applications

**Unit I – Derivatives and Differentiation (21 hours)**

Limit, Continuity and limits of quotients, Derivatives and its geometrical Interpretation, Derivative as a function and calculating derivative, Leibnitz notation and higher derivatives, Trigonometric functions, Linear Approximations, Product and quotient rules, Chain rule, Implicit differentiation, Inverse, exponential and logarithm functions.

**Unit II- Approximations and their Applications (11 hours)**

Measurement error of linear approximation, Quadratic approximation, Newton's method,

1st and 2nd derivative test, Limits and asymptotic, Max min problems, Related application in

real-life problems.

**Unit III – The Integral and Integration Theory (12 hours)**

Mean Value Theorem, Differentials and anti-derivatives, Differential equations, The definite integral, First and Second Fundamental Theorem of Calculus.

**Unit IV – Different Integration Techniques and Application of Calculus (15 hours)**

Areas and Volumes, Average value, Probability, Numerical Integration, Integrals of Trigonometric Power, Trigonometric substitution, Partial fractions, Integration by Parts, Arc length and Surface area.

**Unit V – Polar Co-ordinate systems and Infinite Series (16 hours)**

Parametric curves, Polar co-ordinates, L'Hospital's rule, Improper Integrals, Infinite Series,

Taylor's series.

**Books of Study:**


1. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, Third edition, Wiley India ,2005
2. S. R. Ghorpade and B. V. Limaye, An Introduction to Calculus and Real Analysis, Springer India,2007
3. Michael Spivak, Calculus, Third Edition, Cambridge University, 2008.


**Books of Reference:**

1. G. B. Thomas, Jr. and R. L. Finney, Calculus and Analytic Geometry, 3rd Ed., Pearson Education India 9th Edition 1999.
2. P.M. Fitzpatrick, Advanced Calculus, 2nd Edition, AMS Indian Edition, 2010.

**SEMESTER – I**

| Course Code | Course Title | Core / Elective | L | T | P |
|---|---|---|---|---|---|
| ENG 111 | Basic Electronics | C | 3 | 0 | 2 |

**Unit I Basic Circuits and Diodes (9 hours)**

Ohm's law, Kirchhoff's current and voltage laws. Review of semiconductor materials, doping. Forward and reverse bias characteristics of PN junction diode, depletion and diffusion capacitance, diode piecewise linear model. Design of half-wave, full-wave, bridge rectifiers with and without capacitor, clipping and clamping circuits with and without bias.

**Unit II Bipolar junction Transistor** (**9 hours**)

Introduction to bipolar junction transistors (BJTs), NPN and PNP types. Study of common-base, common-collector and common-emitter configurations using BJTs including their input and output I-V characteristics. Current and voltage gain, BJT in active, cut-off and saturation regions. Q-point of BJT.

**Unit III Field effect Transistor** (**9 hours**)

Introduction to filed effect transistor (FET), operation of JFET, transfer and drain characteristics of JFET, pinch-off region and pinch-off voltage. Introduction to MOSFET, operation of depletion type and enhancement type MOSFET. Transfer and drain characteristics of DMOSFET and EMOSFET. Q-point of FET.

**Unit IV Operational Amplifiers** (**9 hours**)

Introduction to operational amplifier, characteristics of an operational amplifier, negative feedback, inverting and non-inverting op-amps, integrator and differentiator design using op-amp, difference op-amp. Effect of positive feedback, Schmitt trigger circuit.

**Unit V Digital logic fundamentals (9 hours)**

Number systems: binary, decimal, octal and hexadecimal number systems, number system conversions. Logic gates: AND, OR, NOT, NAND, NOR, X-OR, X-NOR. De Morgan's laws, Karnaugh maps. Basic combinational logic blocks: adder, subtractor.

**Textbooks:**

1. "Electronic devices and circuits" by David A. Bell, 5th edition, Oxford University Press, ISBN: 9780195693409.
2. "Electronic Devices and Circuit Theory" by R L Boylestad, L Nashelsky, 15th edition.
3. "Op-Amps and Linear Integrated Circuits" by Ramakant A. Gayakwad, 4th edition.
4. "Digital design" by Morris Mano, 5th edition.

**References:**


1. Engineering Circuit Analysis, by William Hayt, J E Kemmerly and S.M. Durbin, 8th Edition, Mc Graw Hill.
2. "Integrated Electronics" by Millman and Halkias, 2nd edition, Tata McGraw Hill, ISBN: 9780074622452.
3. "Electronic Devices and Circuits" by Jimme J Cathey, 2nd edition. Schaum's Outlines.

**SEMESTER – I**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| PHY 112 | Introduction to Classical Mechanics | Core | 2 | 0 | 0 | 2 |

**Course description** The course aims to cover the fundamental formalism and applications of classical mechanics. It mainly includes basic Newtonian mechanics and special theory of relativity.

**Unit – I Review of Newtonian Mechanics (6 hours)**

Review of Scalars, Vectors and Kinematics, Newton's Laws of Motion and applications, Contact Forces, Static Friction, worked examples, Tension and springs, Pushing Pulling and Tension, Solving Pulley Systems, Hooke's Law and applications.

**Unit – II Circular Motion (6 hours)**

Polar Coordinates, Position and Velocity Vectors, Angular Velocity, Uniform Circular Motion, Direction of the Acceleration, Period and Frequency, Angular Acceleration, Newton’s Second law and circular motion, worked examples

**Unit –III Momentum and Impulse (6 hours)**

Momentum and Impulse, Impulse momentum theorem, Conservation of Momentum, Momentum Diagrams, worked examples, Center of Mass and Motion of the Center of Mass, Center of Mass of 3 Objects, Center of Mass of a Continuous System, Center of Mass of a Uniform Rod and different objects, Velocity and Acceleration of the Center of Mass, Reduction of a System to a Point Particle, Center of Mass Trajectory.

**Unit-IV Work Energy and Collision (8 hours)**

Kinetic Energy and Work in 1D, Work by a Constant Force, Work by a Non- Constant Force, Work-Kinetic Energy Theorem and related problems, Kinetic Energy and Work in 2D and 3D, Work-Kinetic Energy Theorem in 2D and 3D, Worked Example, Conservative and Nonconservative Forces, Path Independence - Gravity, Path Dependence – Friction, Potential Energy due to gravity and of a spring, worked examples, Principle of energy conservation and worked examples, Collision and its type. Collision in 1D and worked examples Collision in 2D and worked examples

**Rotational Motion: (6 hours)**

Motion of a rigid body and moment of inertia, Parallel and perpendicular axis theorem, Moment of inertia of different objects, Torque and Angular momentum, worked examples

**Unit-V Gravitation: (6 hours)**

Central forces, Newton's Law of Gravitation, Principle of Superposition, Acceleration due to gravity and its variation, Gravitational Potential Energy, Kepler's Laws, hyperbolic and parabolic orbits, Satellites' Orbits and Energy, worked examples

**Special Theory of Relativity: (6 hours)**

Michelson-Morley experiment, Postulates of special theory of relativity, Galilean and Lorentz transformations, Relative Velocity, Velocity in ground frame and moving frame. Length contraction and time dilation, Worked examples, Relativistic addition of velocities, Mass energy and Energy-momentum relation.

**Books:**


1. MIT-- 8.01X online course material
2. University Physics with Modern Physics with Mastering Physics, (12th Edition) - Hugh D.Young, Roger A. Freedman and Lewis Ford (Publisher – Pearson Education)
1. Introduction to Classical Mechanics - R. G. Takwale, P. S. Puranik (Publisher - Tata McGraw- Hill Education)


**References:**


1. Classical Mechanics (2011) - Herbert Goldstein (Publisher – Pearson Education)
2. Classical Mechanics (2014) - J. C Upadhayaya (Publisher – Himalaya Publishing House)

**SEMESTER – I**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| CSE 101 | Introduction to Computer Science and Programming | C | 3 | 0 | 2 | 4 |

**Unit I Introduction to Python**:

Knowledge, Machines, Languages, Types, Variables Operators and Branching -– **Core elements of programs**: Bindings, Strings, Input/Output, IDEs, Control Flow, Iteration, Guess and Check – **Simple Programs**: Approximate Solutions, Bisection Search, Floats and Fractions, Newton-Raphson.

**Unit II Functions**:

Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Specifications, Iteration vs Recursion, Inductive Reasoning, Towers of Hanoi, Fibonacci, Recursion on non-numerics, Files

**Unit III Tuples and Lists**:

Tuples, Lists, List Operations, Mutation, Aliasing, Cloning – **Dictionaries**: Functions as Objects, Dictionaries, Example with a Dictionary, Fibonacci and Dictionaries, Global Variables – **Debugging**: Programming Challenges, Classes of Tests, Bugs, Debugging, Debugging Examples– Assertions and Exceptions**,** Assertions, Exceptions, Exception Examples

**Unit IV Classes and Inheritance**:

Object Oriented Programming, Class Instances, Methods Classes Examples, Why OOP, Hierarchies, Your Own Types – **An Extended Example**: Building a Class, Visualizing the Hierarchy, adding another Class, Using Inherited Methods, Gradebook Example, Generators

**Unit V Computational Complexity**:

Program Efficiency, Big Oh Notation, Complexity Classes Analyzing Complexity – **Searching and Sorting Algorithms**: Indirection, Linear Search, Bisection Search, Bogo and Bubble Sort, Selection Sort, Merge Sort

**Books of Study**

1. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher, Revised and Expanded version (Referred by MIT)

**Books of References**


1. Python Programming using problem solving Approach by ReemaThareja, Oxford University, Higher EducationOxford University Press; First edition (10 June 2017),

   ISBN-10: 0199480173

2. Data Structures and Algorithms in Python by Michael T Goodrich and Robertto Thamassia, Micheal S Goldwasser, Wiley Publisher(2016)
3. Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1st edition(6th February 2009)

**SEMESTER – I**

| Subject Code | Subject Title | Core/ Elective | L-T-P | Credits |
|---|---|---|---|---|
| CDC 101 | Soft Skills - I | C | 1-0-0 | 1 |

**UNIT I: Interpersonal Skills**

Understanding the relationship between Leadership Networking & Team work, Realizing Ones Skills in Leadership, Networking & Team Work, and Assessing Interpersonal Skills Situation description of Interpersonal Skill. Team Work Necessity of Team Work Personally, Socially and Educationally.

**UNIT II: Leadership**

Skills for a good Leader, Assessment of Leadership Skills Change Management Exploring - Challenges, Risking Comfort Zone, Managing Change

**UNIT III: Stress Management**

Causes of Stress and its impact, how to manage & distress, Understanding the circle of control, Stress Busters. Emotional Intelligence What is Emotional Intelligence, emotional quotient why Emotional Intelligence matters, Emotion Scales. Managing Emotions.

**UNIT IV: Conflict Resolution**

Conflicts in Human Relations – Reasons Case Studies, Approaches to conflict resolution.

**UNIT V: Decision Making**

Importance and necessity of Decision Making, process of Decision Making, Practical way of Decision Making, Weighing Positives & Negatives.

**References:**

1. Covey Sean, Seven Habit of Highly Effective Teens, New York, Fireside Publishers, 1998.
2. Carnegie Dale, How to Win Friends and Influence People, New York: Simon & Schuster, 1998.
3. Thomas A Harris, I am ok, you are ok, New York-Harper and Row, 1972 4. Daniel Coleman,
Emotional Intelligence, Bantam Book, 2006

**Semester-2**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| CDC-1002 | Soft Skills -2 | Core | 1 | 0 | 0 | 1 |

**Objective:** The most conspicuous perceptual error is the thought that personality is confined to physical appearance alone. Personality is a complete package of an individual's identity; it is infact a person's reality. The development of one's personality is essential for having an impressive image both in the personal & professional areas to create an electrifying impact and a lasting impression.

**UNIT I: Motivation**

Soldiers' Walk and The Japanese Fan (Activities on factors of motivation), Steps to ward off de-motivation

**UNIT II: Creativity & Innovation**

Short Film: Students would be encouraged to make a ten-minute documentary on various topics to enhance the power of aesthetics and precision. This activity is aimed at creating an interest in research and think out of the box.

**UNIT III: Critical & Lateral Thinking**

Fill Me Up, Stimulating Lateral Thinking, The Curious Case of Mary and Kevin (Activities triggering the different types of thinking), The Creative Collage. Critical and lateral thinking can be inculcated with a structured re programming of the neural pathways. These specially designed activities will enhance critical and lateral thinking

**UNIT IV: Team Dynamics**

Story boarding, Frenzy, come to my Island, Striking Cars, Defend the Egg, Tallest Tower (Activities on the different stages of team building, team communication, coordination and collaboration)

**Unit V: Mini Project**

Individual projects on topics provided by faculties.

**SEMESTER – II**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| CHE 101 | Principles of Chemistry | C | 2 | 0 | 2 | 3 |

**Unit I Chemical Bonding (10 hours)**

Ionic, covalent, and metallic bonds. Theories of bonding: Valence bond theory, nature of covalent bond, sigma (σ) bond, Pi (π) bond. Hybridization: Types of hybridization, sp, sp2, sp3, sp3d, d2sp3. Shapes of molecules (VSEPR Theory): $BeCl_2$, $CO_2$, $BF_3$, $H_2O$, $NH_3$, $CH_4$, $PCl_5$, $XeF_2$, $SF_6$, $XeF_4$. Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method), bond order, homo- ($H_2$, $O_2$, $N_2$) and heteronuclear diatomic Molecules (NO, CO). Non-covalent interactions: Van der Waals interactions, dipole-dipole interactions, and hydrogen bonding.

**Unit II Phase Rule and Kinetics (8 hours)**

Phase rule: Introduction. Definition of the terms used in phase rule with examples. Application of phase rule to water system, sulphur system and lead-silver system. Kinetics: Order and molecularity of reactions, zero order, first order and second order reactions.

**Unit III Water Technology (8 hours)**

Standards for drinking water. Methods of Treatment of water for domestic and industrial purposes: Sedimentation, Coagulation, Filtration, Sterilization, Break point chlorination. Determination of Hardness of water by EDTA method. Demineralization of water. Softening of water: Lime-soda Process, Ion exchange process, Zeolite process. Boiler Troubles: Priming, Foaming, Scale, Sludge, Corrosion, Caustic Embrittlement.

**Unit IV Polymer Chemistry (9 hours)**

Classification of polymers: Natural and synthetic. Thermoplastic and Thermosetting. Degree of polymerization. Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic); condensation and copolymerization. Properties of polymers: Tg, Tactility, Molecular weight – weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension.

**Unit V Electrochemistry (10 hours)**

Arrhenius theory of electrolytic dissociation, classification of electrolytes; degree of dissociation of acids, dissociation constant of weak acids, concept of pH and pOH, buffer solutions, solubility product, common ion effect, indicators and theory of acid-base indicators; conductance of solutions- specific, molar and equivalent conductance, variation of molar conductance with dilution for strong and weak electrolytes; Migration

of ions-Kohlrausch's law of independent migration of ions, Ostwald's dilution law; Nernst equation for single electrode and electrochemical cells.

**Books of Study**


1. A. Bahl and B. S. Bahl, G. D. Tuli, Essentials of physical chemistry, S Chand Publication, **2014**, ISBN: 8121929784.
2. P.W. Atkins, T.L. Overton, J.P. Rourke, M.T. Weller and F.A. Armstrong Shriver and Atkins' Inorganic Chemistry, 5$^{th}$Ed., Oxford University Press,London, **2010**, ISBN 978-1-42-921820-7.
3. Atkins, P.W.; de Paula, J. Physical chemistry, 8$^{th}$ ed., **2006** Oxford University Press. ISBN 0-19-870072-5.
4. B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 46$^{th}$ Ed.,**2013**, Vishal Publication Company.
5. F.W. Billmeyer, Text Book of Polymer Science, 3$^{rd}$ Ed., John Wiley & Sons, New York, **2003**.


**Books of Reference**


1. J. Bard and L.R. Faulkner, Electrochemical methods –Fundamentals and Applications, 2$^{nd}$Ed., John Wiley and Sons,**2001**.
2. Jain P.C. & Monika Jain, Engineering Chemistry, Dhanpat Roy & Sons, **2015,** ISBN 10: 8187433175 / ISBN 13: 9788187433170.


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**SEMESTER – II**

| Sub.Code | Sub. Name | Core/ Elective | L-T-P | Credits |
|---|---|---|---|---|
| PHY 211 | Electricity and Magnetism | C | 2-0-2 | 03 |

**UNIT I Introduction to Vector Algebra**

Gradient, Divergence and curl and their physical significances, Gauss and Stokes theorems, Vector operators in different coordinate (Curvilinear, Cartesian, Cylindrical and spherical) systems

**UNIT II Electrostatic**

Coulomb's law, Gauss law, Electric field, Electrostatic Potential, Potential energy of system of charges, Boundary Value problems in electrostatics-solution of Laplace equation in Cartesian system, Method of image charge.

**UNIT III Dielectrics and Polarization**

Electric dipole and dipole moment, Electric potential due to dipole, Electric field intensity due to dipole, Polarization P, Electric displacement D, Electric susceptibility and dielectric constant, Bound volume and surface charge densities, Electric field at an exterior and interior point of dielectric.

**UNIT IV Magneto statics**

Biot-Savart law, Ampere's law for force between two current carrying loops, Ampere's circuital law, Equation of continuity, Magnetic vector potential A, Energy density in magnetic field, magnetization of matter (B, H, M) Magnetic susceptibility and permeability, Hysteresis loss, B-H curve, Diamagnetic, paramagnetic and ferromagnetic substances.

**UNIT V Introduction to Electrodynamics**

Time varying fields: Faradays law of induction, generalization of Amperes' law, Maxwell's

equation (Differential and Integral form), Wave equation and plane waves in free space

**Books of Study:**

1. MIT-- 8.02X online course material
2. Introduction to Electrodynamics (4rd Edition) - David J. Griffiths (Publisher - PHI Learning, Eastern Economy Editions, 2012)
3. Electricity and Magnetism (Reprints 2007, 1st Edition 2001) A. S. Mahajan, A. A.
4. Rangwala, (Publisher - McGraw-Hill Education)

**References:**


1. Electricity and magnetism Edward M Purcell, David J Morin, 3rd edition, Cambridge University, 2013
2. Classical Electrodynamics (3rd Edition) - John David Jackson (Publisher – Wiley)

**SEMESTER – II**

| SUBJECT CODE | SUBJECT TITLE | CORE/ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| ECO 122 | Principles of Economics | Elective | 3 | 0 | 0 | 3 |

**UNIT I Introduction (7 hours)**

Nature and scope of Economics, Principles of Economics, Production Possibility Frontier, opportunity Costs, Comparative Advantage and Scope for Trade. Demand and Supply curves, Equilibrium, Shift in curve versus movement along the curve, Elasticity of Demand and Supply. Changes in equilibrium in response to policy changes, income, tastes and supply "shocks"

**UNIT II Consumer Behaviour (6 hours)**

Consumer preferences and Indifference curve analysis – substitution, income and price effect.

**UNIT III Production and cost (8 hours)**

Production, short- run production function and returns to factor – Average-marginal relationship, long – run production function and laws of return to scale- role of technology.

Cost function and cost structure of a firm in the short- run, long run cost function and cost structure.

**UNIT IV Types of markets (7 hours)**

Perfect competition including shut-down and break-even points. Monopoly. Monopolistic competition and product differentiation.

**UNIT V Equilibrium in the short, medium and long run (10 hours)**

Short-run equilibrium: The Goods market, the money market and General equilibrium (IS-LM)

Medium-run equilibrium: The labour market General Equilibrium (AD-AS)

Long-run equilibrium: Introduction to growth, capital accumulation and growth, technological progress and growth.

**Unit VI The open economy (International trade) (7 hours)**

Openness in goods and financial markets, the goods market, the financial markets and General equilibrium. Exchange rate regime.

**Books of study:**

1. Principles of microeconomics, N. Gregory Mankiw, Publisher: Cengage Learning 5th edition.
2. Macroeconomics, Oliver Blanchard and David R Johnson, Publisher: Pearson; 6thedition.

**Books of reference:**

1. Intermediate Microeconomics: A Modern Approach, Hal R. Varian, Affiliated East-West Press Pvt. Ltd., 8thedition.
2. Principles of Macroeconomics with CourseMate, N. Gregory Mankiw, Cengage India, 6thedition.

**SEMESTER – II**

| Sub. Code | Sub. Name | Core/ Elective | L-T-P | Credits |
|---|---|---|---|---|
| CSE 223 | Data Structures and Algorithms | C | 3-0-2 | 04 |

**UNIT I**

Introduction to C programming, identifiers, basic data types, constants, variables, keywords, operators: arithmetic, relational and logical, increment and decrement operators, conditional operator, assignment operators, Instruction: type declaration, Input-output, conditional, loop control, Arrays, Functions, pointers, dynamic memory management functions Derived types- structures- declaration, definition and initialization of structures, accessing member of structure, arrays of structures, structures and functions, pointers to structures, self-referential structures.

**UNIT II**

Introduction to data structures, Stacks and Queues: representation and application, implementation of stack and queue operations using C. Linked lists: Single linked lists, implementation of link list and various operation using C, Double linked list, circular list.

**UNIT III**

Trees: Tree terminology, Binary tree, Binary search tree, infix to post fix conversion, postfix expression evaluation. General tree, AVL Tree, Complete Binary Tree representation.

**UNIT IV**

Graphs: Graph terminology, Representation of graphs, Path matrix, BFS (breadth first search), DFS (depth first search), topological sorting, Shortest path algorithms.

**UNIT V**

Sorting and Searching techniques – Bubble sort, selection sort, Insertion sort, Quick sort, merge sort, Heap sort, Radix sort, implementation using C. Linear and binary search methods, implementation using C, Hashing techniques and hash functions.

**Books of Study:**

1. “Data structure using C”, Aaron M. Tenenbaum, Y Langsam and Mosche J. Augenstein, Pearson publication.
2. Data structures and Algorithm Analysis in C , Mark Allen Weiss, Pearson publications, Second Edition Programming in C. P. Dey and M Ghosh , Second Edition, Oxford University Press.
3. Programming with C, Byron Gottfried, Mcgrawhill Education, Fourteenth reprint, 2016

**References:**

1. “Fundamentals of data structure in C” Horowitz, Sahani & Anderson Freed, Computer Science Press.
2. “Fundamental of Data Structures” , (Schaums Series) Tata-McGraw-Hill.
3. G. A.V.Pai: “Data Structures & Algorithms; Concepts, Techniques & Algorithms”Tata McGraw Hill.
4. Gilberg and Forouzan, “Data Structure- A Pseudo code approach with C” by Thomson publication

**Semester- II**

| Sub. Code | Sub. Name | Core/ Elective | L-T-P | Credits |
|---|---|---|---|---|
| **MAT 121** | **Multi Variable Calculus** | **C** | **3-0-0** | **03** |

This course covers vector and multi-variable calculus. Topics include vectors and matrices, partial derivatives, double and triple integrals, and vector calculus in 2 and 3-space.

**UNIT I Vector and Matrices (15 hours)**

Vectors, Dot product, Determinants; cross product, Matrices; inverse matrices, Square systems; equations of planes, Parametric equations for lines and curves, Velocity, acceleration, Kepler's second law

**UNIT II Partial Derivatives (16 hours)**

Level curves; partial derivatives; tangent plane approximation, Max-min problems; least squares, Second derivative test; boundaries and infinity, Differentials; chain rule, Gradient; directional derivative; tangent plane, Lagrange multipliers, Non-independent variables, Partial differential equations

**UNIT III Double Integral and Line Integrals in the Plane (15 hours)**

Double integrals, Double integrals in polar coordinates; applications, Change of variables, Vector fields and line integrals in the plane, Path independence and conservative fields, Gradient fields and potential functions, Green's theorem, Flux; normal form of Green's theorem, simply connected regions

**UNIT IV Triple Integrals in 3D (17 hours)**

Triple integrals in rectangular and cylindrical coordinates, Spherical coordinates; surface area, Vector fields in 3D; surface integrals and flux, Divergence theorem: applications and proof.

**UNIT V Surface Integral in 3D (12 hours)**

Line integrals in space, curl, exactness and potentials, Stokes' theorem, Topological considerations, Maxwell's equations.

**Books of Study:**


1. Edwards, Henry C., and David E. Penney. Multivariable Calculus. 6th ed. Lebanon, IN: Prentice Hall, 2002.
2. G. B. Thomas, Jr. and R. L. Finney, Calculus and Analytic Geometry, 9th Edn., Pearson Education India, 1996.


**References:**


1. T. M. Apostol, Calculus - Vol.2, 2nd Edn., Wiley India, 2003.

**Semester- II**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE102 | Introduction to Electrical Engineering | Core | 3 | 0 | 2 | 4 |

**Unit -1 Circuit Analysis**

Definition of charge, voltage, current, power, energy, Ohm's law, Kirchhoff's laws, Concept of Node, Path, Loop, Branch in a circuit, Resistors in Series and Parallel, Voltage and Current Division, Ideal and Practical Voltage and Current Source, Source Transformations, Nodal Analysis, Mesh Analysis, Supernode, Supermesh, Independent and Dependent Voltage and Current Sources. Network Reduction technique using Star – Delta Transformation. Illustrative examples.

**Unit -2 Network Theorems and Two Port Networks**

Superposition Theorem, Thevinin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Reciprocity Theorem, Millman's Theorems--with Independent and Dependent Voltage and Current Sources. Illustrative examples.

One Port Networks, Admittance Parameters, Impedance Parameters, Hybrid Parameters and Transmission Parameters. Illustrative examples.

**Unit -3 Circuit Dynamics and Forced Response**

Step Response of a Series RL, RC (First Order System) and RLC Circuit (Second Order System) under DC Source Excitation--Time Constant, Rise Time, Peak Time, Peak Overshoot/Undershoot and Settling Time. Principle of Duality. Illustrative examples.

**Unit-4 Single-phase AC circuits**

Basic Concepts Related to Generation of Sinusoidal AC Voltage, Definitions of Average Value, Root Mean Square Value, Form Factor and Peak Factor. Steady State Analysis of Pure R, L, C Circuits, RL, RC and RLC circuits with Phasor Diagrams under AC Excitation. Concepts of Resonance, Definitions of Real Power, Reactive Power, Apparent Power and Power Factor. Illustrative examples.

**Unit-5 Three Phase Circuits**: Necessity and Advantages of Three Phase Power Systems, Generation of Three Phase Power. Definition of Phase Sequence, Balanced Supply and Balanced Load. Relationship Between Line and Phase Values of Balanced Star and Delta Connections. Power in Balanced Three-Phase Circuits, Measurement of Three Phase Power by Two-Wattmeter Method. Illustrative examples.

**Text Books:**

1. Electrical Engineering Fundamentals, Vincent Del Toro, Second Edition, PHI.
2. Fundamentals of Electrical Engineering, Second edition, Leonard S. Bobrow, Oxford University press, 2011
3. Introduction to Electric Circuits, Richard C. Dorf and James A. Svoboda, Wiley India Private Limited, Sixth Edition, 2007.
4. A Textbook of Electrical Technology, B.L. Theraja and A.K Theraja, S.Chand and Co. Ltd., 2000.

**Reference Books:**

1. Fundamentals of Electric Circuits, Charles K. Alexander and Matthew N.O. Sadiku, McGraw Hill Higher Education, Third Edition, 2005.
2. Introductory Circuit Analysis, Robert L. Boylestad, Twelfth edition, Pearson, 2012.

**Laboratory Experiments:**

1. To verify Kirchoff's laws.
2. To verify Thevenin's theorem.
3. To verify Superposition theorem.
4. To verify Reciprocity theorem.
5. To verify Norton's theorem.
6. To verify Maximum Power transfer.
7. To study the V-I characteristics of an incandescent lamp.
8. To study and verify the transient behavior of DC network with RL load using MATLAB.
9. To study and verify the transient behavior of DC network with RC load using MATLAB.
10. To study and verify the transient behavior of DC network with RLC load using MATLAB.
11. Measurement single phase power by using three ammeter method.
12. Measurement the single phase power by using three voltmeter method.
13. Measurement of Three Phase Power by Two-Wattmeter Method

**Semester-III**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| **EE201** | Electrical and Electronics Measurement | Core | 2 | 1 | 0 | 3 |

**Unit -1 Fundamentals of measurement (8 Hours)**

Introduction to measurement and instrumentation, Classification of instruments, Definition of accuracy, precision, resolution. Errors in measurement, classification of errors, Illustrative examples

**Unit -2 Analog Instrument and Measurements (8 Hours)**

General features, construction and torque equation of moving coil, moving iron, electrodynamometer, principle of operation of electrodynamic wattmeter, power measurements construction, theory and operation of AC energy meter, induction type energy meter, testing of energy meter

**Unit -3 Instrument Transformers (8 Hours)**

Advantages of instrument transformer, principle and operation of current and potential transformer

**Unit-4 Bridges and Potentiometer (8 Hours)**

Principle, operation and application of Crompton' DC potentiometer, classification and measurement of resistance - Wheatstone's bridge, Kelvin's double bridge, measurement of inductance-Maxwell's bridge, measurement of capacitance and loss angle-De Sauty's bridge

**Unit-5 Oscilloscopes and Multimeters (8 Hours)**

General features, construction of cathode ray oscilloscope, measurement of voltage and current, measurement of phase and frequency (Lissajous Patterns), Digital Voltmeters(DVMs) and types of DVMs

**Text Books:**

1.A Course in Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney,19th Revised Edition, Dhanpat Rai & Co.

2. Electrical Measurements and Measuring Instruments, E.W.Golding and F.C.Wides,3rd Edition, Wheeler Publishing

3. Electrical and Electronic Measurement and Instrumentation, R.K. Rajput,4th Edition, S.Chand

**Reference Books:**

1. Electrical Measurement Analysis, Ernest Frank, McGraw Hills, Latest Edit

**Semester-III**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| MAT 131 | Differential Equations | Core | 3 | 0 | 0 | 3 |

- **Lecture Time**: Three lectures per week, each of 50 minutes. The class hours include tutorial sessions and there will be total 15 such sessions.
- **Prerequisites:**
  - MAT-112 (Single Variable Calculus), in particular, being familiar with vectors, differentiation, and integration.

- **Course Overview**: This introductory course on ordinary differential equations (**ODEs**) covers the theory, solution techniques, and applications surrounding linear and non-linear first and second-order differential equations, including systems of equations.

**Course Objective:** The emphasis should be on mastering the mathematics and use techniques, skills, modern tools for engineering practices. Further this course helps to identify, formulate, & solve engineering problems

- **Learning Outcome**: Upon successful completion of this course, you should be able to:
  - model some elementary physical situations by writing an appropriate differential equation.
  - be able to solve first order simple, linear, and separable equations.
  - solve higher order differential equations using characteristic roots, undetermined coefficients, and the Laplace transform.
  - understand the qualitative nature of the solution to the linear and non-linear systems of equations.

**UNIT-1 First Order Differential Equations:**

Geometric meaning of $y' = f(x, y)$, Direction Fields, Euler's Method, Classification of ODEs ( Linear, Non-linear, Exact, Separable), Integrating Factor, Bernoulli Equations, Initial Value Problem, Modelling (Population Dynamics, Radioactivity, Subsonic Flight).

**UNIT-2 Second and Higher Order Linear ODEs:**

Homogeneous Linear ODEs, Modelling of Free Oscillations of a Mass-Spring System, Euler-Cauchy Equations, Non-homogeneous ODEs, Variation of Parameters, Modelling (Forced Oscillations. Resonance, Electric Circuits)

**UNIT-3 System of ODEs:**

Modelling Engineering problems (Electric Network, Mixing problem in two tanks etc.) as systems of ODEs, Wronskian, Phase-Plane Method, Critical Points & Stability, Qualitative Methods for Nonlinear Systems, Nonhomogeneous Linear Systems of ODEs.

**UNIT-4 Series Solutions of ODEs:**

Introduction to power series method, Legendre's equation & polynomials, Frobenius Method, Bessel's Equations & Functions.

**UNIT-5 Laplace Transforms:**

Laplace transforms of standard functions, Shifting Theorems, Transforms of derivatives and integrals, Unit step function, Dirac's delta function, Inverse Laplace transforms, Convolution theorem (without proof). Application: Solutions of ordinary differential equations using Laplace transforms.

**Books:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

**References:**

1.Mary L. Boas, *Mathematical Methods in Physical Sciences*, 3rd Edition, Wiley-India.

2.G. F. Simmons, *Differential Equation with Applications and Historical Notes*, TATA McGraw Hill.

3.S. Vaidyanathan, *Advanced Applicable Engineering Mathematics*, CBS Publishers.

**Semester-III**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE202 | Electrical Circuit Analysis | Core | 2 | 1 | 0 | 3 |

**Unit 1-Basic circuit analysis (8 Hours)**

Network Reduction Technique using Star–Delta Transformation, analysis of electric circuits with dependent sources: voltage dependent voltage source, voltage dependent current source, voltage dependent voltage source, current dependent current source and current dependent and voltage source.

**Unit 2- Two Port Networks (8 Hours)**

Two Port Networks, Admittance Parameters, Impedance Parameters, Hybrid Parameters and Transmission Parameters. Illustrative examples.

**Unit 3- Network theorems with both DC and AC source (8 Hours)**

Superposition Theorem, Thevinin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Reciprocity Theorem, Millman's Theorems--with Independent and Dependent Voltage and Current Sources. Illustrative examples.

**Unit 4- Transient analysis of circuits (8 Hours)**

Step Response of a Series RL, RC (First Order System) and RLC Circuit (Second Order System) under DC Source Excitation--Time Constant, Rise Time, Peak Time, Peak Overshoot/Undershoot and Settling Time. Principle of Duality. Transient Response Analysis of Series RL, RC and RLC Circuits with AC Source Excitation. Illustrative examples.

**Unit 5- Graph theory and Passive Filters (8 Hours)**

**Graph theory-** Concept of Tree, Branch, Tree link, Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials. Principle of Duality, Illustrative Examples

**Passive filters**-Concept-Ideal and practical, properties and uses and classification of filter, concept of low pass and high pass filter using reactive elements. Illustrative examples.

**Text Book:**

1. Charles K Alexander and Mathew N O Sadiku, “Fundamentals of Electric Circuits”, Tata McGraw-Hill, 3rd Ed, 2009.

2. Abhijit Chakrabarti, “Circuit Theory Analysis and Synthesis”, Dhanpat Rai & Co.; Seventh - Revised edition 2018.

**Reference Books:**

1. James S. Kang, “Electric Circuits”, Cengage India 2016.

2. Robert L. Boylestad, “Introductory Circuit Analysis”, 12th Edition, Pearson, 2018.

**Semester-III**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| ENG 101 | Fundamentals of Mechanical Engineering | Core | 3 | 0 | 0 | 3 |

**Unit I** **(8 hours)**

Sources of Energy, Types of Prime Movers, Force, Mass, Pressure, Work, Power, Energy, Heat, Temperature, Internal Energy, Enthalpy, Efficiency, Zeroth Law, First Law, Thermodynamic System, Different Types of Fuels, Non-Conventional Energy - Wind, Solar, Bio, Global Warming.

**Unit II** (**8 hours)**

Introduction - Fluids, Physical Properties of Fluids, Relationship Between Stress and Strain-Rate For Newtonian and Non-Newtonian Fluids, Description of Fluid Flow, Classification of Flows-Laminar and Turbulent Flows, Measurement of viscocity.

**Unit III** **(8 hours)**

Heat Engines - External, Internal, Carnot, Rankine, Otto, Diesel Cycles; Steam Boilers - Fire Tube, Water Tube Boilers, Valves; IC Engine - Components, 2 Stroke, 4 Stroke, Engine Performance, Efficiency.

**Unit IV** **(8 hours)**

Pumps- Reciprocating, Rotary, Pump Efficiency; Air Compressors-Reciprocating/Rotary; Refrigeration and Air Conditioning- Principles of Working; Brakes, Clutches and Couplings, Drives- Transmission of Power- Belt Drive, Gear Drive, Chain Drive.

**Unit V** **(8 hours)**

Mechanics of Materials- Engineering Materials, Material Properties- Tensile Strength, Toughness, Malleability, Hardness, Ductility, Stiffness, Brittleness, Elasticity, Plasticity, Creep, Fatigue, Failure, Stress-strain plots, failures

**Books of Study:**

1. Elements of Mechanical Engineering, S Trymbak Murthy, IK International Publishing, 2010.
2. Elements of Mechanical Engineering, R K Rajput, Laxmi Publications Ltd, 2005.

**References:**

1. Elements of Mechanical Engineering, V.K . Manglik, PHI Publications, 2013.
2. Elements of Mechanical Engineering, B. L. Theraja, S.Chand Ltd. 1999.
3. Elements of Mechanical Engineering, Sadhu Singh, S.Chand and Company Ltd. 2013.

**Semester – III**

| Sub. Code | Sub. Name | Core/ Elective | L-T-P | Credits |
|---|---|---|---|---|
| CDC 211 | Soft Skills III | C | 1-0-0 | 01 |

**UNIT I Quantitative Reasoning**

Number properties, Percentage, Ratio and proportion, Profit and loss, Simple and compound interest, Speed, Time and work, Powers and roots, Linear equations, Quadratic equations, Pipes, cisterns.

**UNIT II Verbal Reasoning**

Proposition, Premise: Syllogism: Verbal Analogies, Verification of truth of the statement, Assertion and reason, Situation reaction test, Decision making, Alpha-numerical sequence puzzle.

**UNIT III Non-Verbal Reasoning**

Symbols and their relationships, Arithmetical Decision making, Analytical functions, Space

Visualization, Blood Relations, Seating Arrangement, Coding-Decoding, Input- Output.

**UNIT IV Data Analysis and Interpretation**

Statistics: Average, Median, Mode, Range, Standard deviation, Graphical and Numerical Methods for Describing Data, Interpretation of data in tables and graphs, Permutations and Venn diagrams Counting Methods, Probability, Distributions of Data, Random Variables, and Probability Distributions.

**UNIT V Emotional Intelligence**

Self-Awareness, Self-Regulation, Social Skills, Empathy and Motivation.

**Books of Study:**

1. R.S. Agarwal, A Modern Approach to Verbal & Non Verbal Reasoning, S. Chand

Publication
2. P. Anand, Quantitative Aptitude, Wiley, 2015

**References:**


1. The Games People Play, Eric Berne; Grove Press; 1964 of Human Interaction; Joseph Luft; Mayfield Publishing. 1969
2. Emotional Intelligence; Daniel Goleman; Bantam Books, 1995

**Semester IV**

| Sub. Code | Sub. Name | Core/ Elective | L-T-P | Credits |
|---|---|---|---|---|
| CDC 212 | Soft skills - IV | C | 1-0-0 | 01 |

**Objective:** A grasp over numeric skills enable an individual to apply the mathematical techniques to situations that call for the interpretation or evaluation of quantitative information. The logical ability is sharpened through the practice of quantitative reasoning. Emotional intelligence on the other hand enables the development of intra and interpersonal relationship skills. Both these disciplines are aimed at enhancing the professional and personal effectiveness of the students.

**UNIT I Quantitative Reasoning (12 hours)**

Number properties (3), Speed, Time and work (2), Powers and roots (1), Pipes, cisterns(1). Problems on Clock, Calendar and Cubes (3), Height and Distance (1) , Logarithms (1)

**UNIT II Non-Verbal Reasoning (7 hours)**

Alpha-numerical sequence puzzle, Symbols and their relationships, Blood Relations, Seating Arrangement, Coding-Decoding, Input- Output, test Direction Sense Test

**UNIT III Data Analysis and Interpretation (10 hours)**

Sets and Functions (1), Data Sufficiency (2), Statistics: Average, Median, Mode, Range, Standard deviation (2), Graphical and Numerical Methods for Describing Data, Interpretation of data in tables and graphs (2), Permutations and Venn diagrams Counting Methods, Probability (3).

**UNIT IV Emotional Intelligence II**

Self-Awareness, Self-Regulation, Social Skills, Empathy and Motivation.

**Books of Study:**

1. R.S. Agarwal, A Modern Approach to Verbal & Non Verbal Reasoning, S. Chand Publication
2. P. Anand, Quantitative Aptitude, Wiley, 2015

**References:**


1. The Games People Play, Eric Berne; Grove Press; 1964
2. Of Human Interaction; Joseph Luft; Mayfield Publishing. 1969
3. Emotional Intelligence; Daniel Goleman; Bantam Books, 1995

**Semester IV**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| MAT 151 | Linear Algebra | C | 3 | 0 | 2 | |

**Unit I – Vector Space** (**15 hours)**

Elimination, LU factorization, null-spaces and other subspaces, bases and dimensions, vector spaces, complexity

**Unit II- Factorization** **(16 hours)**

Orthogonality, projections, least-squares, QR, Gram–Schmidt, orthogonal functions

**Unit III – Matrices** **(15 hours)**

Eigenvectors, determinants, similar matrices, Markov matrices, ODEs, symmetric matrices, definite matrices,

**Unit IV – Iterative methods** **(17 hours)**

Defective matrices, SVD and principal-components analysis, sparse matrices and iterative methods, complex matrices, symmetric linear operators on functions.

**Unit V – Applications** **(12 hours)**

Matrices from graphs and engineering.

** *Class hours include tutorial sessions. There are total 15 such sessions consisting of 2 hours each.*

**Books of Study:**


1. G. Strang, Linear Algebra and Its applications, Nelson Engineering, 4th Edn., 2007
2. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India, 1996


**References:**


1. S. Axler, Linear Algebra Done Right, 2nd Edn., UTM, Springer, Indian edition, 2010.
2. G. Schay, Introduction to Linear Algebra, Narosa, 1997.

**Semester IV**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE-204 | Electrical machines-I | CORE | 3 | 0 | 2 | 4 |

**Course Outcomes:**

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

- ✓ Understand the concepts of magnetic circuits.
- ✓ Understand the operation of dc machines.
- ✓ Analyse the differences in operation of different dc machine configurations.
- ✓ Analyse single phase and three phase transformers circuits.

**Unit-I Magnetic fields and magnetic circuits (6 Hours)**

Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savant Law; Visualization of magnetic fields produced by a bar magnet and a current Carrying coil - through air and through a combination of iron and air; influence of highly Permeable materials on the magnetic flux lines.

**Unit -II: Electromagnetic force and torque (9 Hours)**

B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency

**Unit-III: DC machines (8 Hours)**

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per Pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

**Unit-IV: DC machine - motoring and generation (7 Hours)**

Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

**Unit -V: Transformers (12 Hours)**

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

**Text / References:**

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

2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.

5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

**Semester - IV**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| **ME 211** | Introduction to Solidworks | Core | 0 | 0 | 2 | 1 |

**Unit 1**

GUI familiarity, features, commands, shortcuts, mouse features, drop down menus etc

**Unit 2**

Sketch entities Inference line, centreline, line, circle, arc, ellipse, rectangle, slots, polygon, spline, points, text, snap, grid Sketch Tools Fillet, chamfer, offset, trim, extend, mirror, copy, rotate, scale, sketch

**Unit 3**

Blocks, create blocks, add/remove, explode, relations, dimensioning

**Unit 4**

Part modeling, extrude, revolve, swept, loft, reference, curves, fillet, pattern

**Unit 5**

Assembly modeling, mating, manipulating components

**Unit 6**

Surface modeling tools

**Unit 7**

All views of the object, dimensions

Drafting tools

**Unit 8**

Simulation express, stress-strain analysis

**References**

Solid works user manual

**Semester V**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE-301 | Electrical machines-II | CORE | 3 | 0 | 2 | 4 |

**Course Outcomes:**

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

- ✓ Understand the concepts of rotating magnetic fields.
- ✓ Understand the operation of ac machines.
- ✓ Analyse performance characteristics of ac machines.

**Unit-I: Fundamentals of AC machine windings (8 Hours)**

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; singleturn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

**Unit-II: Pulsating and revolving magnetic fields (4 Hours)**

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

**Unit-III: Induction Machines (12 Hours)**

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors.Generator operation. Self-excitation. Doubly-Fed Induction Machines.

**Unit-IV: Single-phase induction motors (6 Hours)**

Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

**Unit-5: Synchronous machines (10 Hours)**

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent

circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

**Text/References:**


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.

**Semester V**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 304 | Power system-I | CORE | 3 | 0 | 2 | 4 |

Course Outcomes:

**Unit-I Supply Systems (6 hours)**

Electric supply system, Typical AC power supply Scheme, Comparison of DC and AC transmission, Advantages of high transmission voltage, Various system of power transmission, Comparison of conductor material in overhead system, Comparison of conductor material in underground system, Comparison of various systems of transmission, Elements of a transmission line, Economics of power transmission, Economical choice of conductor size, Economic choice of transmission voltage, Requirement of satisfactory electric supply.

**Unit-II: Mechanical Design of Transmission Lines: (6 hours)**

Main components of over head lines, Conductor materials, Line supports, insulators, Types of insulators, Potential distribution over suspension insulators, String efficiency, Methods of improving string efficiency, Sag in over head lines and sag calculations.

**Unit-III: Inductance and Resistance of Transmission Line: (8 hours)**

Introduction, Definition of Inductance, Flux Linkages of an isolated current carrying conductor,

Inductance of a single phase two wire line, Conductor types, Flux Linkages of one conductor in group, Inductance of composite conductor lines, Inductance of three phase lines, Double circuit three phase lines, Bundled conductors, Resistance, Skin effect and Proximity effect, Magnetic field induction.

**Unit-IV: Capacitance of Transmission Lines: (6 hours)**

Introduction, Electric field of a long straight conductor, Potential difference between two conductors of a group of parallel conductors, Capacitance of a two wire line, Capacitanceof a three phase line with equilateral spacing, Capacitance of a three phase line with unsymmetrical spacing, Effect of earth on transmission line capacitance, Method of GMD, Bundled conductors, Electrostatic induction.

**Unit-V: DC and AC distribution: (6 hours)**

Distribution system, classification of Distribution systems, AC distribution, DC distribution, Connection scheme of distribution system, Types of DC distributors, DC distribution

calculations, DC distributor fed at one end, uniformly loaded distributor fed at one end, distributor fed at both ends, Distributor with both concentrated and uniform loading, Ring distributor, Ring main distributors with interconnector, AC distribution calculations, Methods of solving AC distribution problems, 3-phase unbalanced loads – 4 wire, Star connected unbalanced loads, Ground detectors.

**Unit-VI: Representation of power system component: (6 hours)**

Introduction, Single phase Representation of balanced three phase networks, The one line diagram and impedance or reactance diagram, Per unit system, Advantages of pu system, Per unit representation of a transformer, Per unit impedance diagram of a power system, Complex power, The steady state model of synchronous Machine, Power factor and power control, Salient pole synchronous generator, Loading capability diagram [3], Power transformer, Transmission of electric power, System protection , Representation of load.

**Unit-VII: Underground cables:**

Underground cables, Construction of cables, Classification of cables, Cables for three phase services, Insulation resistance of a single core cable, Capacitance of a single core cable, Dielectric stresses in a single core cable, Most economical conductor size in a cable, Grading of cables, Capacitance grading and inter sheath grading, Capacitance of threecore cable and measurement of capacitance.

**Reference Books:**


1. Modern Power System Analysis by D P Kothari and I J Nagrath : Fourth Edition: McGraw Hill
2. Principles of Power System by V.K.Mehta and RohitMehta : Reprint 2014 : S. Chand [1,
3. Power Systems Analysis : John J. Grainger and W. D. Stevenson Jr., Tata McGrawHill International.
4. Electrical Power systems: C. L .Wadhwa, 5th Edition, New Age InternationalPublishers.
5. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
6. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
7. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.

. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

**Semester V**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 305 | Advanced control systems design | CORE | 2 | 0 | 2 | 3 |

**Unit-I: Model Based Controller Design (10 hours)**

Introduction, Control structures and performance measures, Time and frequency domain performance measures, Design of controller, Design of controller for SISO system, Controller design for TITO processes, Limitations of PID controllers, PI-PD controller for SISO system PID-P controller for Two Input Two Output system, Effects of measurement noise and load 1

**Unit-II: Frequency Domain Based Identification (4 hours)**

Identification of dynamic models of plants, Relay control system for identification, Off-line identification of process dynamics, On-line identification of plant dynamics 1

**Unit-III: Time Domain Based Identification (20 hours)**

State space based identification, State space analysis of systems, State space based identification of systems, Identification of simple systems, Identification of FOPDT model, Identification of second order plus dead time model, Identification of SOPDT model, Steady state gain from asymmetrical relay test, Identification of SOPDT model with pole multiplicity**,** Existence of limit cycle for unstable system, Identification procedures , Identification of underdamped systems Off-line identification of TITO systems, On-line identification of TITO systems, Review of time domain based identification, DF based analytical expressions for on-line identification, Model parameter accuracy and sensitivity, Improved identification using Fourier series and wavelet Transform, Reviews of DF based identification.

**Unit-IV: Design of Controllers (6 hours)**

Advanced Smith predictor controller, Design of controllers for the advanced Smith predictor Model-free controller design, Model based PID controller design, Model based PI-PD controller design, Tuning of reconfigurable PID controllers

**References:**


1. S. Majhi,Advanced Control Theory-Relay Feedback Approach, Cengage Asia/India Pvt.Ltd, 2009.
2. A. Johnson and H. Moradi, New Identifications and Design Methods,Springer - Verlag, 2005.
3. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, 2008.

**Semester VI**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 306 | Power system-II | CORE | 3 | 0 | 2 | 4 |

Cours Course Outcomes:

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

- Use numerical methods to analyse a power system in steady state.
- Understand stability constraints in a synchronous grid.
- Understand methods to control the voltage, frequency and power flow.
- Understand the monitoring and control of a power system.
- Understand the basics of power system economics.

**Unit-I: Power Flow Analysis (7 hours)**

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 nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

**Unit-II: Stability Constraints in synchronous grids (8 hours)**

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 numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

**Unit-III: Control of Frequency and Voltage (7 hours)**

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. Shunt Compensators, Static VAR compensators and STATCOMs.Tap Changing Transformers. Power flow control using embedded dc links, phase shifters

**Unit-IV: Monitoring and Control (6 hours)**

Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment.

Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.

**Unit-V: Power System Economics and Management (7 hours)**

Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.

**Text/References:**

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

2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.

3. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.

4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.

5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”,

Wiley, 2012.

**Semester VI**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 308 | Power electronics | ELECTIVE | 3 | 0 | 2 | 4 |

Course Outcomes:

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

- Understand the differences between signal level and power level devices.
- Analyse controlled rectifier circuits.
- Analyse the operation of DC-DC choppers.
- Analyse the operation of voltage source inverters.

**Unit-II: Power switching devices (8Hours)**

Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

**Unit-II: Thyristor rectifiers (7Hours)**

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

**Unit- III: DC-DC buck converter (5Hours)**

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

**Unit-IV: DC-DC boost converter (5Hours)**

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

**Unit-V: Single-phase voltage source inverter (10Hours)**

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage

**Unit-IV: Three-phase voltage source inverter (8Hours)**

Power circuit of a three-phase voltage source inverter, switch states, instantaneous outputvoltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

**Text/References:**

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.

**Semester VI**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 309 | Electrical machines-III | ELECTIVE | 3 | 0 | 2 | 4 |

**UNIT - I:**

Synchronous Machine & Characteristics: Constructional Features of round rotor and salient pole machines – Armature windings – Integral slot and fractional slot windings; Distributed and concentrated windings – distribution, pitch and winding factors – E.M.F Equation. Harmonics in generated EMF – suppression of harmonics – armature reaction - leakage reactance – synchronous reactance and impedance – experimental determination - phasor diagram – load characteristics.

**UNIT - II:**

Regulation of Synchronous Generator: Regulation by synchronous impedance method, M.M.F. method, Z.P.F. method and A.S.A. methods – salient pole alternators – two reaction analysis – experimental determination of Xd and Xq (Slip test) Phasor diagrams – Regulation of salient pole alternators.

**UNIT - III:**

Parallel Operation of Synchronous Generator: Synchronizing alternators with infinite bus bars – synchronizing power torque – parallel operation and load sharing - Effect of change of excitation and mechanical power input. Analysis of short circuit current wave form – determination of sub-transient, transient and steady state reactances.

**UNIT - IV:**

Synchronous Motors: Theory of operation – phasor diagram – Variation of current and power factor with excitation – synchronous condenser – Mathematical analysis for power developed. Power Circles: Excitation and power circles – hunting and its suppression – Methods of starting – synchronous induction motor.

**UNIT - V:**

Single Phase Motors & Special Machines: Single phase Motors: Single phase induction motor – Constructional Features-Double revolving field theory Equivalent circuit - split-phase motors - Capacitor start Capacitor run motors. Principles of A.C. Series Motor-Universal motor, Stepper motor shaded pole motor, (Qualitative Treatment only).

**Text Books:**

1. Electrical Machines – by P.S. Bimbra, Khanna Publishers.
2. Principles of Electrical Machines, V. K. Mehta, Rohit Mehta, S. Chand Publishing.
3. Electromachanics - III (Synchronous and single phase machines), S. Kamakashiah, Right Publishers.
4. Electric Machines, I. J. Nagrath & D. P. Kothari, Tata Mc Graw Hill Publishers.
5. Performance and Design of AC Machines, MG. Say, BPB Publishers.
6. Theory of Alternating Current Machinery, Langsdorf, Tata McGraw-Hill Companies.
7. Electric machinery, A.E. Fitzerald, C. Kingsley and S. Umans, Mc Graw Hill Companies.
8. Electric Machines, Mulukutla S. Sarma, Mukesh K. Pathak, Cengage Learning.
9. Fundamentals of Electric Machines, B. R. Gupta, Vandana Singhal, New Age International Publishers.
10. Electrical Machines, M. V. Deshpande, PHI Learning Private Limited.
11. Electrical Machines, R. K. Srivastava, Cengage Learning.

**Semester VII**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 403 | Power system –III | CORE | 3 | 0 | 2 | 4 |

**UNIT-I : Objectives of Power System Operation (6 hours )**

Power Systems in Restructured Environment; Distributed and Dispersed Generation; Environment Aspects of Electric Power Generation.

**UNIT-II: Economic Operation of Energy Generation Systems (10 hours)**

Generation Cost Curves; Economic Operation of Thermal System; Plant Scheduling;Transmission Loss and Penalty Factor; Hydro-Thermal Scheduling; Concept of Reserves and Constraints; Unit Commitment.

**UNIT-III: Automatic Generation Control (8 hours)**

Concept of AVR and ALFC Loops, Significance of Double Loop in ALFC; Exciter and VAR Control; Single Area Load Frequency Control; Two Area Load Frequency Control; Frequency Response.

**UNIT-IV: Compensation in Power System (8 hours )**

Reactive Power Sensitivity and Voltage Control; Load Compensation with Capacitor Banks; Line Compensation with Reactors; Shunt and Series Compensation; Fixed Series Capacitors; Thyristor Controlled Series Capacitors, Introduction to SVC and STATCOM.

**UNIT-V: Power System Transients [8]**

Types of System Transients; Overvoltage in Transmission Lines; Propagation of Surges an Travelling Waves; Protection Against Lightning and Surges;

**Text Books**

1. Power System Engineering, Kothari & Nagrath, Mc Graw Hill

2. Power System Analysis, Granger and Stevension, Mc Graw Hill

3. Electric Power Genration operation and control, Wood and Woolenberg, Willey.

4. Power system stability and Control, P. Kundur , Mc Graw Hill

5. Modern power system analysis, Kothari & Nagrath, Mc.Graw Hill

6. Power system Analysis, Nagsarkar & Sukhija, Pearson

7. Power system analysis, operation and control, Chakrabarti and Halder, PHI

**Semester VII**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 404 | High voltage engineering | Core | 3 | 0 | 1 | 4 |

**Unit-I: Electrostatic fields and field stress control (4 hours )**

Electrical field distribution and breakdown strength of insulating materials - fields in homogeneous, isotropic materials - fields in multi-dielectric, isotropic materials - numerical method: Finite Element Method (FEM), charge simulation method (CSM)

**Unit-II: Electrical breakdown in gases (5 hours)**

Gases as insulating media - ionization and decay processes, Townsend first ionization coefficient, photoionization, ionization by interaction of metastable with atoms, thermal ionization, deionization by recombination, deionization by attachment–negative ion formation, examples - cathode processes – secondary effects, photoelectric emission, electron emission by positive ion and excited atom impact, thermionic emission, field emission, Townsend second ionization coefficient, secondary electron emission by photon impact, examples - transition from non-self-sustained discharges to breakdown, the Townsend mechanism, examples - the streamer or 'kanal' mechanism of spark, examples - the sparking voltage–Paschen's law, penning effect, the breakdown field strength, breakdown in non-uniform fieldspartial breakdown, corona discharges,

**Unit-III: Breakdown in liquid and solid dielectrics (7 hours)**

Liquid as insulators, breakdown in liquids - electronic breakdown, suspended solid particle mechanism, cavity breakdown, examples – static electrification in power transformers, transformer oil filtration, transformer oil test, alternative liquid insulations like vegetable oils, esters and silicon oils - breakdown in solids, intrinsic breakdown, streamer breakdown, electromechanical breakdown, edge breakdown and treeing, thermal breakdown, erosion breakdown, tracking -breakdown of solid dielectrics in practice, partial discharges in solid insulation, solid dielectrics used in practice

**Unit-IV: Generation of high voltages (7 hours)**

Generation of high direct voltages, half and full wave rectifier circuits, voltage multiplier circuits, Van de Graff generators, electrostatic generators, examples - generation of alternating voltages, testing transformers, cascaded transformers, resonant transformers, examples - impulse voltages, Standard lightning and switching surge and associated parameters and their corrections, impulse voltage generator circuits, Marx circuit, operation, design and construction of impulse generators, examples - impulse current generator – control systems

**Unit-V: Measurement of high voltages (7 hours)**

High direct voltage measurement, peak voltage measurements by spark gaps, sphere gaps, reference measuring systems, uniform field gaps, rod gaps, factors affecting sphere gap measurements, examples – electrostatic voltmeters - ammeter in series with high ohmic resistors and high ohmic resistor voltage dividers - generating voltmeters and field sensors – the measurement of peak voltages, the Chubb–Fortescue method, highvoltage capacitors for measuring circuits - voltage dividing systems and impulse voltage measurements, digital recorders, errors inherent in digital recorders

**Unit-VI: Over voltages, testing procedures and insulation coordination (4 hours)**

The lightning mechanism, energy in lightning, nature of danger -laboratory high-voltage testing procedures and statistical treatment of results, examples - insulation coordination, insulation level, statistical approach to insulation coordination, correlation between insulation and protection levels - modern power systems protection devices, M O A – metal oxide arresters

**Unit-VII: Non-destructive insulation test techniques (5 hours )**

Measurement of d.c. resistivity - dielectric loss and capacitance measurements, the Schering bridge, current comparator bridges, Tan Delta measurement, null detectors - partial-discharge (PD) measurements, the basic PD test circuit, PD currents, PD measuring systems within the PD test circuit, measuring systems for apparent charge, sources and reduction of disturbances, other PD quantities, calibration of PD detectors in a complete test circuit, digital PD instruments

**Unit-VIII: High voltage testing:**

Testing of insulators and bushings, testing of isolators and circuit breakers Testing of cables, testing of transformers - testing of surge diverters - radio interference measurements - design, planning andlayout of high voltage laboratory

**Books:**

1. Kuffel, E., Zaengl W.S., Kuffel J., “High Voltage Engineering: Fundamentals” ButterworthHeinmann (A division of Reed Educational & Profession Publishing Limited), 2nd Edition, 2000.

2. Naidu M. S. and Kamaraju V., “High Voltage Engineering”, fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2009.

3. Rakosh Das Begamudre, “High Voltage Engineering, Problems and Solutions”, New Age International Publishers, New Delhi, 2010.

4. Dieter Kind, Kurt Feser, “High Voltage Test Techniques”, Reed educational and professional publishing ltd. (Indian edition), New Delhi-2001

5. M. Khalifa, "High Voltage Engineering-Theory and Practice", Marcel Dekker, Inc. New York and Basel,1990.

6. Hugh M. Ryan, “High Voltage Engineering and Testing”, 2nd edition, The Institution of Electrical Engineers, London, United Kingdom, 2001.

**References:**

1. Wadhwa C.L., "High Voltage Engineering", third edition, New Age publishers, New Delhi, 2010.
2. Chakrabarti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., a Text Book on Power System Engineering, DhanpatRai (2008).
3. Wadhwa, C.L., Electrical Power Systems, New Age International (P) Limited, Publishers (2008).
4. Gupta, B.R., Power System Analysis and Design, S. Chand (2009).
5. Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw–Hill (2007).
6. Pabla, A.S., Electric Power Distribution, McGraw Hill (2008).
7. Stevenson, W.D., Power System Analysis, McGraw–Hill (2007).

**Electives**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| **ECE 212** | Digital Electronics | Core | 3 | 0 | 2 | 4 |

**Unit I Digital Fundamentals (9 hours)**

Binary addition and subtraction, 1's and 2's complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, SOPs, POSs, 4, 5 variable k-map, don't care conditions, prime implicants and essential prime-implicants. Quine-McCluskey method.

**Unit II Combinational Logic Circuits** (**9 hours**)

4- bit binary adder and subtractor, Binary Parallel Adder – Carry look ahead adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder, binary multiplier.

**Unit III Sequential Logic Circuits I** (**9 hours**)

Latches, Flip flops (FF) – SR, JK, T, D, Master/Slave FF, Triggering of FF, analysis and design of clocked sequential circuits, Stable and Unstable states, Moore/Mealy models.

**Unit IV Sequential Logic Circuits II** (**9 hours**)

Counters – Ripple Counters, Ring Counters. Registers – Shift Registers, Universal Shift Register, comparison between Synchronous and Asynchronous Sequential logic circuits.

**Unit V Memory Devices (9 hours)**

Memories – ROM – RAM, types of RAM and ROM. Programmable Logic Devices: Programmable Logic Array (PLA) – Programmable Array Logic (PAL). Sequential programmable devices, Field Programmable Gate Arrays – Implementation of combinational logic circuits using ROM, PLA, PAL.

**Text books:**


1. M. Morris Mano, "Digital Design", 5th Edition, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2014.


**References:**


1. John F.Wakerly, "Digital Design", Fourth Edition, Pearson/PHI, 2008.
2. John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.
3. Charles H.Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.

4. Donald P.Leach and Albert Paul Malvino, “Digital Principles and Applications”, 6th Edition, TMH, 2006.
5. Thomas L. Floyd, “Digital Fundamentals”, 10th Edition, Pearson Education Inc, 2011.
6. Donald D.Givone, “Digital Principles and Design”, TMH, 2003.
7. Anil K. Maini, “Digital Electronics”, Wiley, 2014

**ELECTIVE**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| ENG 211 | Signals And Systems | ELECTIVE | 3 | 0 | 2 | 4 |

1. The course contains 3 lecture hours and 2 practical hours per week.
2. Prerequisites: Single variable calculus.

**Unit I Signals: Classification, Transformations, Representation** (**9 hours**)

Classification of signals: continuous-time/discrete-time, even-odd, periodic-aperiodic, energy-power, random-deterministic. Standard signals: impulse, step, ramp, exponential and sinusoids. Transformations of the independent variable: shifting, scaling and reversal.

**Unit II Systems: Classification and Domain Analysis** (**9 hours**)

Classification of systems: linear-nonlinear, time-invariant/time-variant, memory, causal, continuous-time/discrete-time. LTI System properties: causality, memory, stability, and invertibility. Impulse response, linear convolution, graphical method to solve convolution.

**Unit III Continuous & Discrete time Signals** (**9 hours**)

Representation of periodic signals using Fourier series. Introduction to sampling and reconstruction, aliasing. Continuous time Fourier transform (CTFT), properties of CTFT, convolution property. Discrete time Fourier transform (DTFT) and its properties.

**Unit IV Laplace Transform and z- Transform** (**9 hours**)

Introduction to Laplace transform, region of convergence, properties of Laplace transform, inverse Laplace transform, initial and final value theorems. Introduction to Z-transform and its region of convergence, properties of Z-transform, inverse Z-transform, the unilateral Z-transform.

**Unit V Discrete Fourier Transform and FFT** **(9 hours)**

Introduction to discrete Fourier transform (DFT) and its relation to DTFT, properties of DFT, inverse DFT, convolution using DFT. Computation of DFT using fast Fourier transform (FFT), decimation in time FFT, decimation in frequency FFT.

**Text books:**

1. “Signals and Systems” by Oppenheim, Wilsky and Nawab, Prentice Hall, 2nd edition. ISBN: 9780138147570.
2. “Signals and Systems” by Simon Haykin and Berry Van Veen, 2nd edition, ISBN: 9780471164746.

**References:**

1. “Principles of Signal Processing and Linear Systems” by B P Lathi, 2nd edition, ISBN: 9780198062271.
2. “Signals and Systems using MATLAB” by Louis F Chaparro, 2014 edition, Academic Press, ISBN: 9780123948434.

**Semester-4**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| **ECE 211** | Analog Electronics | Core | 3 | 0 | 2 | 4 |

**UNIT – I**
**(9hours)**

Current sources and active loads, difference, intermediate and output stages including Miller capacitors for frequency computation; analysis And Design of Small Signal Low Frequency BJT Amplifiers: Review of transistor biasing, Classification of Amplifiers – Distortion in amplifiers, Analysis of CE, CC, and CB Amplifiers and CE Amplifier with emitter resistance, low frequency response of BJT Amplifiers, effect of coupling and bypass capacitors, Design of single stage RC coupled amplifier Different coupling schemes used in amplifiers, Analysis of Cascaded RC Coupled amplifiers, Cascode amplifier, Darlington pair.

**UNIT–II Transistor At High Frequency: (9 hours)**

The Hybrid- pi ($\pi$ ) – Common Emitter transistor model, CE short circuit current gain, current gain with resistive load, single stage CE transistor amplifier response, Gain-bandwidth product.

**UNIT – III FET Amplifiers: [9hours)**

Analysis of JFET Amplifiers, Analysis of CS, CD, CG JFET Amplifiers, comparison of performance with BJT Amplifiers, Basic Concepts of MOS Amplifiers, – MOSFET – MOSFET Characteristics in Enhancement and Depletion mode – MOS Small signal model, Common source amplifier with resistive, Diode connected and Current source loads, Source follower, Common Gate Stage, Cascode and Folded Cascode Amplifier – frequency response.

**UNIT-IV Positive & Negative Feedback in Amplifiers: (9hours)**

Classification of amplifiers, Concepts of feedback – Classification of feedback amplifiers – General characteristics of negative feedback amplifiers – Effect of Feedback on Amplifier characteristics – Voltage series, Voltage shunt, Current series and Current Shunt Feedback configurations – Simple problems. Condition for oscillations. RC and LC type Oscillators – Frequency and amplitude stability of oscillators – Generalized analysis of LC oscillators, Quartz, Hartley, and Colpitts Oscillators – RC-phase shift and Wien-bridge oscillators.

**UNIT – IV Large Signal Amplifiers:**

Class A Power Amplifier, Maximum Value of Efficiency of Class – A Amplifier, Transformer Coupled Amplifier, Push Pull and Complimentary Symmetry Class B and Class AB Power Amplifiers – Principle of operation of class –C Amplifier, Transistor Power Dissipation, Heat

Sinks. Tuned Amplifiers: Introduction, Q-Factor, Small Signal Tuned Amplifiers, frequency response of tuned amplifier

**Text books:**


1. Bezhad Rizavi "*Fundamentals of Microelectronics"*, Wiley, (2006)
2. Electronic Devices and Circuits, David A. Bell – 5th Edition, Oxford.
3. Electronic Devices and Circuits, S. Salivahanan, N. Suresh Kumar, A Vallvaraj, 5th Edition, MC GRAW HILL EDUCATION.
4. Electronics circuits and applications, Md H Rashid, Cengage 2014


**References:**


1. Integrated Electronics, Jacob Millman, Christos C Halkias, McGraw Hill Education
2. Electronic Devices and Circuits theory– Robert L. Boylestead, Louis Nashelsky, 11th Edition, 2009, Pearson.
3. Electronic Devices Conventional and current version -Thomas L. Floyd 2015, person

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| CDC-204 | Quantitative and Verbal Ability | | 1 | 0 | 0 | 1 |

**OBJECTIVE:** A grasp over numeric skills enable an individual to apply the mathematical techniques to situations that call for the interpretation or evaluation of quantitative information. The logical ability is sharpened through the practice of quantitative reasoning. Emotional intelligence on the other hand enables the development of intra and interpersonal relationship skills. Both these disciplines are aimed at enhancing the professional and personal effectiveness of the students. Verbal ability enhances the communication prowess and enables efficiency in competitive exams.

**UNIT I Quantitative Reasoning**

Speed, Time and work, Powers and roots, Pipes, cisterns. Problems on Clock, Calendar and Cubes, Height and Distance, Logarithms

**UNIT II** N**on- Verbal Reasoning**

Alpha-numerical sequence puzzle, Symbols and their relationships, Blood Relations, Seating Arrangement, Coding-Decoding, Input- Output, test Direction Sense Test,

**UNIT III Data analysis and Interpretation**

Graphical and Numerical Methods for Describing Data, Interpretation of data in tables and graphs, Permutations and Venn diagrams Counting Methods, Probability.

**UNIT IV Verbal Ability**

Conditionals, Tense Forms, Verb Forms,

**UNIT V Verbal Ability**

Phrasal Verbs, Cohesion and Coherence

**Text Book :**


1. R.S. Agarwal, A Modern Approach to Verbal & Non Verbal Reasoning, S. Chand Publication
2. P. Anand, Quantitative Aptitude, Wiley, 2015

**Semester-V**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| OE-IV | Power plane Engineering | ELECTIVE | 3 | 0 | 0 | 3 |

**Objectives:**

To provide an overview of power plants and the associated energy conversion issues

**Contents:**

**Unit-1: Coal based thermal power plants**

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam andheating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

**Unit –II: power plant combustion cycles**

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

**Unit-IV: Nuclear power plant**

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal, cooled reactors, safety measures for nuclear power plants.

**Unit-V; hydro power plant and renewable energy source**

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems

Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologiesincluding waste disposal options for coal and nuclear plants.

**Text Books:**

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.

2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.

3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| OE-IV | FPGA programming | ELECTIVE | 3 | 0 | 0 | 3 |

**Course Description:**

Introduction to FPGA Architectures, FPGA design flow, partitioning, placement and routing algorithms. Technology mapping for FPGAs, case studies. The goal of the course is to introduce digital design techniques using field programmable gate arrays (FPGAs). We will discuss FPGA architecture, digital design flow using FPGAs, and other technologies associated with field programmable gate arrays. The course study will involve extensive lab projects to give students hands-on experience on designing digital systems on FPGA platforms.

**Topics:**

1. Introduction to ASICs and FPGAs
2. Fundamentals in digital IC design
3. FPGA & CPLD Architectures
4. FPGA Programming Technologies
5. FPGA Logic Cell Structures
6. FPGA Programmable Interconnect and I/O Ports
7. FPGA Implementation of Combinational Circuits
8. FPGA Sequential Circuits
9. Timing Issues in FPGA Synchronous Circuits
10. Introduction to Verilog HDL and FPGA Design flow with using Verilog HDL
11. FPGA Arithmetic Circuits
12. FPGAs in DSP Applications
13. Design Case Study: Design of SDRAM Controller
14. Design Case Study: Design of Halftone Pixel Converter
15. Programming FPGAs in Electronic Systems
16. Design issues in complex systems containing both FPGA and Microprocessors

Books:

1. Brown, S. D., Francis, R. J., Rose, J. and Vranesic, Z G. Field programmable Gate arrays. Kluwer, 1992.
2. Betz, V., Rose, J. and Marquardt, A. Architecture and CAD for Deep-submicron FPGAs. Kluwer, 1999.
3. Trimberger, S. M. FPGA Technology. Kluwer, 1992.
4. Oldfield, J. V. and Dorf, R. C. FPGAs: Reconfigurable logic for rapid prototyping and implementation of digital systems. John Wiley, 1995
5. Steve Kilts, “Advanced FPGA Design,” Wiley Inter -Science, ISBN 9780470054376:
6. P. Chu, “FPGA Prototyping by Verilog Examples,” Wiley, 2008
7. P. Chu, “FPGA Prototyping by VHDL Examples,” Wiley, 2008

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| OE-V | Microprocessors and microcontrollers | ELECTIVE | 3 | 0 | 2 | 4 |

**Unit-I: Architecture of Microprocessors (12 hours)**

Microprocessor architecture: introduction to microprocessor and microcomputer architecture, pins and signals, register organization, timing & control module, 8085 instruction timing & Execution, instruction set and assembly language programming of 8085 –instuction set of 8085, memory & I/O addressing, assembly language programming using 8085 instruction set, use of stack & subroutines, data transfer techniques, 8085 interrupts

**Unit-II: Interfacing & support chips with 8086 (10 hours)**

Interfacing ROMs, RAMs along with the explanation of timing diagrams memories, Interfacing with peripheral ICs like 8255, 8254, 8279, 8259,2716,2764,6116&6264etc. Microprocessor based system development aids, programmable DMA controller 8257,programmable interrupt controller :8259, Applications: Delay calculation, square wave generation, interfacing of key boards, LEDs, LCDs, ADCs, and DACs etc.

**Unit-III: advanced microprocessor(10 hours)**

Basic features od advance microprocessors, intel 8086(16 bit processor):-8086 architecture, register organization, signal descripitions, physical memory organization, addressing modes,instuction formats, instrution set & simple assembly language programmes,8086 interrupts,simple application: delay calculation, square wave generation

**Unit IV: Microcontroller(10 hours)**

introdution for microcontrollers, microcontroller&microprocessor,Embedded verses external memory devices, CISC&RISC processors, Havard & von neuman Architectures, 8051 microcontroller. MCS-51 Architectures,registers,stack pointer & program counter. 8051 pin description, connections, parallel I/O parts, memory organization , 8051 addesing modes& instrutions,8051 assembly language programming tools, simple apllication: delay calculation, square wave generation, interfacing of LCDunit etc**.**

**Text Books:**

1. 0000 to 8085 Introduction to microprocessor for scientist & engineers by Ghosh & Sridhar, PHI.
2. Fundamentals of microprocessor and microcontroller by B. RAM, Dhanpat Rai Publications.
3. Advanced microprocessor and peripherals (architecture, programming and interfacing) by A.K.Roy & K.M.Bhurchandi, TMH Publication.
4. Microprocessor, theory and applications by A.V.Deshmukh, TMH Publication.

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 303 | Advanced control theory | CORE | 3 | 0 | 0 | 3 |

**UNIT – I: State space analysis and design**

Introduction State Space Representation – Solution of state equation – State transition matrix, –Canonical forms – Controllable canonical form – Observable canonical form, Jordan Canonical Form. Introduction to state model-effect of state feedback, necessary and sufficient conditions for arbitrary pole placement design of state observer separation principle servo design state feedback with integral control State Space Representation – Solution of state equation – State transition matrix, –Canonical forms – Controllable canonical form – Observable canonical form, Jordan Canonical Form.

**UNIT – II: Phase plane analysis:**

Features of linear and nonlinear systems, common physical non linearity methods of linearization concept of phase portraits, singular points, limit cycles, construction of phase portraits, phase plane analysis of linear and nonlinear systems isoclines method

**UNIT – III: Describing function analysis:**

Introduction to nonlinear systems, Types of nonlinearities, describing functions, Introduction to phase–plane analysis.

**UNIT–IV: Stability analysis:**

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

**UNIT–V: Calculus of variations**

: Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints – Euler lagrangine equation.

**UNIT –VI Optimal control:**

Linear quadratic optimal regulator (LQR) problem formulation – Optimal regulator design by parameter adjustment (Lyapunov method) – Optimal regulator design by continuous time algebraic riccatti equation (CARE) – Optimal controller design using LQG framework.

**Learning Outcomes**

- State space representation of control system and formulation of different state models are reviewed.
- Able to design of control system using the pole placement technique is given after introducing the concept of controllability and observability.
- Able to analyse of nonlinear system using the describing function technique and phase plane analysis.
- Able to analyse the stability analysis using lypnov method.
- Minimization of functionals using calculus of variation studied.
- Able to formulate and solve the LQR problem and riccatti equation.

**Text Books**


1. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3rd edition, 1998
2. Automatic Control Systems by B.C. Kuo, Prentice Hall Publication


**Reference Books**


1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition, 1996
2. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
3. Digital Control and State Variable Methods – by M. Gopal, Tata Mc Graw– Hill Companies, 1997.
4. Systems and Control by Stainslaw H. Zak , Oxford Press, 2003.
5. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.

**Special Electrical Machines Syllabus**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 307 | Special machines | ELECTIVE | 3 | 0 | 0 | 3 |

**UNIT I Synchronous reluctance motors EE6703 Special Electrical Machines Syllabus**

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

**UNIT II Stepper Motors EE6703** Special Electrical Machines Syllabus

Constructional features – Principle of operation – 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– Applications.

**UNIT III Switched Reluctance Motors EE6703** Special Electrical Machines Syllabus

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 – Applications.

**UNIT IV Permanent Magnet Brushless D.C. MOTORS**

Permanent Magnet materials – Minor hysteresis loop and recoil Line-Magnetic Characteristics – Presence coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation – Power Converter Circuits and their controllers – Motor characteristics and control– Applications.

**UNIT V Permanent Magnet Synchronous Motors (PMSM) EE6703** Special Electrical Machines Syllabus

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– Applications.

Text Books:

1. K.Venkataratnam, ‘Special Electrical Machines’, Universities Press (India) Private Limited, 2008.
2. T.J.E.Miller, ‘Brushless Permanent Magnet and Reluctance Motor Drives’, Clarendon Press, Oxford, 1989.
3. T.Kenjo, ‘Stepping Motors and Their Microprocessor Controls’, Clarendon Press London, 1984.
4. R.Krishnan, ‘Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application’, CRC Press, New York, 2001.
5. P.P. Aearnley, ‘Stepping Motors – A Guide to Motor Theory and Practice’, Peter Perengrinus London, 1982.
6. T. Kenjo and S. Nagamori, ‘Permanent Magnet and Brushless DC Motors’, Clarendon Press, London, 1988.
7. E.G. Janardanan, ‘Special electrical machines’, PHI learning Private Limited, Delhi, 2014.

**Semester-VII**

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 402 | Electrical machines design | ELECTIVE | 3 | 0 | 0 | 3 |

**Objectives:**

- To study mmf calculation and thermal rating of various types of electrical machines.
- To design armature and field systems for D.C. machines.
- To design core, yoke, windings and cooling systems of transformers.
- To design stator and rotor of induction machines.
- To design stator and rotor of synchronous machines and study their thermal behaviour.

**UNIT-I Introduction**

Major considerations in Electrical Machine Design - Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal considerations – Heat flow – Temperature rise and Insulating Materials - Rating of machines – Standard

specifications.

**UNIT-II DC Machines**

Output Equations – Main Dimensions – Choice of Specific Electric and Magnetic Loading – Maganetic Circuits Calculations - Carter's Coefficient - Net length of Iron –Real & Apparent flux densities – Selection of number of poles – Design of Armature – Design of commutator and brushes – performance prediction using design values.

**UNIT-III Transformers**

Output Equations – Main Dimensions - kVA output for single and three phase transformers – Window space factor – Design of core and winding – Overall dimensions – Operating characteristics – No load current – Temperature rise in Transformers – Design of Tank - Methods of cooling of Transformers.

**UNIT-IV Induction Motors**

Output equation of Induction motor – Main dimensions – Choice of Average flux density – Length of air gap- Rules for selecting rotor slots of squirrel cage machines – Design of rotorbars & slots – Design of end rings – Design of wound rotor – Magnetic leakage calculations– Leakage reactance of polyphase machines- Magnetizing current - Short circuit current – Operating characteristics- Losses and Efficiency.

**UNIT-V Synchronous Machines**

Output equations – choice of Electrical and Magnetic Loading – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length – Design of rotor –Design of damper winding –Determination of full load field mmf– Design of field winding – Design of turbo alternators –

Rotor design.

**Books:**

1. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi,1984.

2. M.V.Deshpande “Design and Testing of Electrical Machine Design” Wheeler Publications,2010.

**References:**

1. A.Shanmuga Sundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 2007.

2. R.K.Agarwal “ Principles of Electrical Machine Design” Esskay Publications, Delhi, 2002.

3. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford

and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987.

| SUBJECT CODE | SUBJECT TITLE | CORE/ ELECTIVE | CREDITS | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | C |
| EE 402 | Computer techniques in power system | ELECTIVE | 3 | 0 | 0 | 3 |

**Unit-I: General Introduction (2 hours)**

Modern Power Systems Operation and Control, Different types of Power System Analysis.

**Unit-II: AC Power Flow Analysis (10 hours)**

Introduction, Modeling of Power System Components, Power Flow Equations, Formation of Bus Matrix, Power Flow Solution Algorithms, Newton Raphson Load Flow Method, Fast Decoupled Load Flow Method and DC Load Flow Method, AC-DC System Power Flow Analysis-Sequential and Simultaneous Solution Algorithms.

**Unit-III Sparse Matrices (3 hours)**

Sparsity directed Optimal Ordering Schemes, Solution Algorithms – LU Factorization, Bifactorization and Iterative Methods.

**Unit-IV: Analysis of Faulted Power System (08 hours)**

Symmetrical and Asymmetrical Faults, Zbus Formulation, Short Circuit Analysis of Large Power Systems using Zbus Analysis of Open Circuit faults.

**Unit-V: Security Analysis (6 hours )**

Basic Concepts,Static Security Analysis at Control Centers, Contingency Analysis, Contingency Selection.

**Unit -VI Stability Analysis (10 hours )**

Classification of Power System Stability, Classical Model of Synchronous Machines and Excitation System, Transient Stability Analysis of Multi-Machine Systems, Eigen Analysis of Dynamical Systems, Small Signal Stability Analysis using Classical Model, Basic Concepts of Voltage Stability Analysis.

**Reference Books:**


1. O.I.Elgerd, Electric Energy Systems Theory – An Introduction, McGraw-Hill, 1988.
2. A.R.Bergen and Vijay Vittal,Power Systems Analysis, Pearson Education Asia, 2001.
3. J.J. Grainger and W.D.Stevenson, Power System Analysis, Mc Graw-Hill, New York, 1994.
4. I.J. Nagrath and D.P.Kothari, Power System Engineering, Tata Mc Graw Hill Publishing Co., 1994.
5. J.D. Glover, M.Sarma and T.J. Overbye, Power System Analysis and Design, Fourth Edition, Thomson Engineering Press, 2008.
6. P.Kundur, Power System Stability and Control, Mc GrawHill, 1994.
7. A.J. Wood and B.F. Wollenberg, Power Generation Operation and Control, John Wiley & Sons, 1996.
8. C.W. Taylor, Power System Voltage Stability, Mc Graw Hill, 1994.
9. L.Phillipson and H.L.Willis, Understanding Electric Utilities and Deregulation, Marcel Dekker