Major Core Courses (MCC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501MA01	Linear Algebra & Calculus	FC	2	1		3	50	50	100	-
2501CH02	Applied Chemistry	FC	2		1	3	50	50	100	-
2501ME01	Engineering Graphics	FC	1		2	3	50	50	100	-
2501ME03	Engineering Workshop	FC			1	1	100	-	100	-
2501PH02	Modern Physics	FC	2		1	3	50	50	100	-
2501MA02	Differential Equations & Vector Calculus	FC	2	1		3	50	50	100	-
2501EE02	Electromagnetic Theory	FC	2	1		3	50	50	100	-
2501EE03	Electrical Network Analysis-I	FC	2		2	4	50	50	100	-
2501MA05	Numerical Methods & Integral Transforms	IC	2	1		3	50	50	100	DEVC
2501EE04	DC Machines &Transformers	IC	2		2	4	50	50	100	ENA-I
2501EE05	Electrical Network Analysis-II	IC	2		2	4	50	50	100	ENA-I
2501MA06	Complex Variables & Statistical Methods	IC	2	1		3	50	50	100	LAC
2501EE06	Electric Power Generation & Distribution Systems	IC	2			2	50	50	100	ENA-I/BEEE
2501EE07	Induction & Synchronous Machines	IC	2		2	4	50	50	100	EMT
2501EE08	Analog Electronic Circuits	IC	2	1	1	4	50	50	100	-
2501EC01	Digital Electronics & Logic Design	IC	2		2	4	50	50	100	-
2501EE09	Microprocessor & Interfacing	IC	2	1	1	4	50	50	100	DELD
2501EE10	Power Electronics	IC	2	1	1	4	50	50	100	-
2501EE11	Control Engineering	IC	2		2	4	50	50	100	-
2501EE12	Electric Power Transmission Systems	IC	2	1		3	50	50	100	EPGDS
2501EE13	Electrical Measurements & Instrumentation	IC	2	1	1	4	50	50	100	-

2501EE14	Power System Analysis	AC	2		2	4	50	50	100	EPTS
2501EE39	Energy converters	AC	2	1		3	50	50	100	PE
2501EE16	Power System Operation & Control	AC	2		2	4	50	50	100	PSA
	Total		**45**	**11**	**25**	**81**				

Linear Algebra and Calculus

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E)

	L	T	P	C
Course Code: 2501MA01	**2**	**1**	**0**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

- **CO1:** Solve the system of Linear equations
- **CO2:** Calculate Eigen values and Eigen vectors
- **CO3:** Apply differential calculus for one and several variable functions
- **CO4:** Calculate the Maximum value and Minimum value of a function of several variables
- **CO5:** Compute areas and volumes using multiple integrals

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

System of Linear Equations :

Vector Space, Linear Independence,Rank of a matrix by echelon form, normal form, Inverse of Non-singular matrices by Gauss-Jordan method, Solutions of Linear Systems: Existence, Uniqueness,Solving the system by Gauss elimination method.

Practice(Using any computational tool)

1. Variables, arithmetic operations, elementary mathematical functions.
2. Defining row vector, column vector, Arithmetic operations on matrices
3. Finding transpose of a matrix, inverse of a matrix, determinant of a matrix
4. Rank of a matrix, solving system of linear equations.

UNIT – II

Eigenvalues, Eigenvectors : Eigenvalues and properties(without proof), Eigenvectors, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), Quadratic forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation,Nature of Quadratic forms.

Practice(Using any computational tool):

Computing eigen values and eigen vectors, matrix diagonalization.

UNIT – III

One Variable Calculus:Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), Problems and applications on the above theorems.

Several Variable Calculus: Limit, Continuity, partial derivatives and their geometrical interpretation.

Practice(Using any computational tool): Basics of plotting,Plot graphs of single variable functions

UNIT – IV

Functions of several variables: Total differentialand differentiability, derivatives of composite and implicit functions,derivatives of higher order and their commutativity,Euler's theorem on homogeneous functions, Taylor's and Maclaurin's expansion of functions of two variables. Jacobians, maxima and minima, constrained maxima/minima problems using Lagrange's method of multipliers.

Practice(Using any computational tool): Plot graphs of various multi variable functions

UNIT – V

Multiple Integrals: Double integrals, triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

Practice(Using any computational tool): Plotting the region of Integration

Students are advised to use any computational / AI Tool like Wolfrum Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 5th Edition (9th reprint), 2021· ISBN978-8184875607
2. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 5th Edition, 2018.ISBN-13. 978-1292174341

Reference Books:

1. Advanced Engineering Mathematics, Michael Greenberg, Pearson publishers, 9th edition.ISBN-13. 9788177585469
2. Higher Engineering Mathematics, H. K. Dass, Er. R. Verma, S-Chand publishers, 3rd edition 2023.ISBN 9788121938907

Web Links:

1. https://archive.nptel.ac.in/courses/111/104/111104137/
2. https://archive.nptel.ac.in/courses/111/107/111107108/
3. https://www.khanacademy.org/math/linear-algebra/
4. https://www.khanacademy.org/math/multivariable-calculus

Applied Chemistry

(Common to EEE, ECE, CSE, IT, CSE(DS) & AIML)

	L	T	P	C
CourseCode:2501CH02	**2**	**0**	**1**	**3**

Course Outcomes:

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

CO1: Explain the fundamentals of polymers and explore engineering applications.

CO2: Interpret the principles and applications of Electrochemical cells.
CO3: Summarize the fundamentals of Computational Chemistry and its applications.
CO4: Illustrate the fundamentals of nano and smart materials and their applications.
CO5: Apply the knowledge of water treatment and E-waste management.

Mapping of Course Outcomes with Program Outcomes

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

Unit 1: Polymer Chemistry

Introduction to polymers, functionality of monomers, chain growth and step growth polymerization, coordination polymerization, with specific examples and methods of polymerization (Suspension polymerization and Emulsion Polymerization) Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - PTFE and Bakelite
Polymer composites – Composites as structural material; Synthesis and applications of Kevlar and Carbon fibers.
Conducting polymers - Polyacetylene- Mechanism of conduction – applications (polymers in sensors, self-cleaning windows)
Biodegradable polymers - Introduction, Polyglycolic acid - synthesis, degradation and uses.

Practice:
Preparation of a polymer (Bakelite)
Determination of molecular weight of polymer using Ostwald's viscometer

Unit 2: Electrochemistry and Applications

Electro chemical cell, Nernst equation, cell potential calculations and numerical problems,

Primary cells – Zinc-air battery, Secondary cells –Ni-Cd and, Lead-Acid battery, lithium-ion batteries- working of the batteries including cell reactions; Fuel cells, hydrogen-oxygen, Methanol-Oxygen fuel cell– working of the cells. Polymer Electrolyte Membrane Fuel cells (PEMFC)

Electrochemical sensors – potentiometric sensors with examples, amperometric sensors with example (Glucose Electrochemical sensor)

Practice

1. Conduct metric titration of strong acid vs strong base
2. Potentiometric titration of red-ox
3. P^H-metric titration of Acid-Base
4. Determination of Glucose by Electrochemical sensor

Unit 3: Computational Chemistry

Computational Quantum Chemistry and its applications, Prediction of Molecular Properties using Computational Chemistry, Molecular Modeling and Structure - molecular modeling today: overview of problems, tools, and solution analysis. Techniques for Conformational Sampling-Monte Carlo, global optimization, etc.

Practice

1. Molecular docking to predict the interaction energy between molecules

Unit 4: Nano and Smart Materials

Introduction to nano materials and general applications, basic chemical methods of preparation (top down and bottom up approach) - Sol-gel method. Applications of Carbon nano tubes and Fullerenes, Graphene (water treatment and drug delivery)

Characterization of nanomaterials by SEM and TEM (only Principle).
Smart materials and their engineering applications
Shape memory materials- Poly L-Lactic acid,
Thermo response materials – Poly acryl amides, Poly vinyl Amides

Practice

1. Preparation of nano particles by green synthesis
2. Characterization of nanoparticles (SEM & TEM)

Unit V Water Treatment & E-Waste Management

Water treatment: Introduction, hardness of water, types, determination of hardness by EDTA method, disadvantages of hard water, removal of hardness by Zeolite and ion exchange method, Desalination of water – reverse osmosis and Electrodialysis.

E-Waste: Introduction, sources of e-waste, Composition, Characteristics, and Need of e-waste management. Toxic materials used in manufacturing electronic and electrical products; Recycling: Recycling of Li-Ion batteries. Extraction of copper from E-waste.

Practice

1. Determination of Hardness of a ground water sample
2. Determination of Chloride content in given water sample
3. Estimation of dissolved oxygen in given water sample

Textbooks:

1. Prasanta Rath, S.Aruna Kumari "Engineering Chemistry", CENGAGE Learning (ISBN 978-93-5350-651-3) (ISBN 93-5350-651-4).
2. Shikha Agarwal, Engineering Chemistry Fundamentals and Applications, Cambridge 2nd Edition (ISBN 978-1-108-72444-9).

Reference Books:

1. Uppal M.M, Jain and Jain. Engineering Chemistry, Khanna Publishers, 35th Edition, 2013.(ISBN 978-817-409-2625)
2. Dr. S.S. Dara, Dr. S.S. Umare, A Textbook of Engineering Chemistry, S.Chand Publication2022 .(978-935—283-6068)
3. Andrew R.Leach Molecular Modelling Principles and applications. (201) IIed. PrenticeHall. (978-935-501-2585).

Web Links:

1. https://archive.nptel.ac.in/courses/104/106/104106096/
2. https://archive.nptel.ac.in/courses/104/105/104105124/
3. https://archive.nptel.ac.in/courses/104/106/104106137/
4. https://nptel.ac.in/courses/11810203

Engineering Graphics

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

Course Code: 2501ME01	L	T	P	C
	1	0	2	3

Course Outcomes:

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

- **CO1:** Apply the principles of engineering drawing to construct Engineering curves
- **CO2:** Construct projections of points and lines.
- **CO3:** Demonstrate visualization skills of projections of planes.
- **CO4:** Demonstrate visualization skills of projections of solids and development of surfaces
- **CO5:** Construct isometric and orthographic views of simple solids.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1		2			1	1		
CO2	3	2	1		2			1	1		
CO3	3	2	1		2			1	1		
CO4	3	2	1		2			1	1		
CO5	3	2	1		2			1	1		

Practice:

1. **Introduction to Engineering Graphics**
   Introduction to AutoCAD, Dimensioning, elements of dimensioning, system of dimensioning, and Conventions in Drawing.

2. **Construction of Cycloids and Involutes**
   a) Construction of Cycloid, Epicycloid and Hypocycloid
   b) Involute of a pentagon and circle

3. **Introduction to Orthographic Projection**
   a) Principles of Projection
   b) Orthographic Projection – Four Quadrants.
   c) First angle & Third angle Projection with examples, reference plane, importance of reference lines or Plane.
   d) Projections of a point situated in any one of the four quadrants.

4. **Projection of straight lines-I:**
   a) Projections of straight lines parallel to both reference planes.
   b) Projections of straight lines perpendicular to one reference plane and parallel to other reference plane
   c) Projections of straight line parallel to one plane & inclined to another plane

5. **Projection of straight lines-II:**
   a) Projections of straight line inclined to both reference planes

6. **Projection of planes:**
   a) Regular planes perpendicular to both reference planes, Parallel to one reference plane and inclined to the other reference plane

   Ex: Rectangle, Pentagon, Hexagon and Rhombus

7. **Projection of planes**
   a) Projections of Planes inclined to both reference planes Ex: Rectangle, Pentagon, Hexagon and Rhombus.

8. **Projection of solids**
   a) Axis Perpendicular to H.P and Axis Perpendicular to V.P

   Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone
   b) Axis Parallel to H.P and V.P

   Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

9. **Projection of solids**
   a) Projection of Solids with axis inclined to one reference plane and parallel to another plane

   Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

10. **Development of Surfaces**
    a) Development of Prisms and Cylinder simple cases

11. **Development of Surfaces**
    a) Development of Pyramids and Cone simple cases

12. **Conversion of Isometric views to Orthographic views**
    a) Practice figure - 1
    b) Practice figure - 2

Additional Practice:

1. **Conversion of Isometric views to Orthographic views**
   a) Practice figure - 3
   b) Practice figure - 4
2. **Conversion of Orthographic views to Isometric views**
   a) Practice figure - 1
   b) Practice figure - 2

Text Books:

1. Engineering Drawing, N. D. Bhatt, Charotar Publishing House, 54th edition, 2024, ISBN : 9789385039706.
2. Engineering Drawing and Graphics , Venugopal, New Age Publications, 2nd edition, 2019, ISBN: 97881225015452.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2021,ISBN: 978-9385983177.
2. Computer Aided Engineering Graphics, T. Jeyapoovan,Vikas Publishing house, New Delhi, 1stEdition, 2023, ISBN : 9789356743199.

Web Links:

1. https://nptel.ac.in/courses/112103019/
2. https://academy.autodesk.com/authenticated-home-user
3. https://www.sciencedirect.com/book/97808108391/engineering-drawing-from-thebeginning

Engineering Workshop

(Common to CE, EEE, ME, ECE, PT & Min.E)

Course Code: 2501ME03	L	T	P	C
	0	0	1	1

Course Outcomes:

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

- **CO1:** Prepare various wooden joints.
- **CO2:** Demonstrate various sheet metal models.
- **CO3:** Develop the basic knowledge of house wiring.
- **CO4:** Develop the basic knowledge of plumbing.
- **CO5:** Practice various welded joints.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1				1	1	2	1		1
CO2	1	1				1	1	2	1		1
CO3	2	2				1	1	2	1		1
CO4	1	2				1	1	2	1		1
CO5	2	2				1	1	2	1		1

Practice:

1. To make a T-Lap joint from the given wooden workpieces.
2. To make a dovetail lap joint from the given wooden workpieces.
3. To make a taper tray using the given sheet metal.
4. To make a funnel using the given sheet metal.
5. To make a square tin using the given sheet metal.
6. To connect three bulbs by using series and parallel connections.
7. To give connection to a bulb by using staircase wiring.
8. To prepare wiring for a tube light with switch control.
9. To prepare a PVC pipe joint by using the given circuit1.
10. To prepare a PVC pipe joint by using the given circuit2.
11. To make a butt joint using the given M.S pieces by arc welding.
12. To make a lap joint using given M.S pieces by arc welding

Additional Practice:

1. To make a cross lap joint from the given wooden workpieces.
2. To make an open scoop using the given sheet metal.
3. To make a T-joint using given M.S pieces by arc welding.

Text Books:

1. Work shop Manual , P.Kannaiah & K.L.Narayana SciTech Publishers, 2nd edition, ISBN: 978-8183711302.
2. Elements of Workshop Technology, Vol I by S.K. Hajra Choudhury, S.K. Hajra Choudhury & Nirjhar Roy, Media Promoters and Publishers Pvt. Limited, 14th edition. ISBN: 8185099146.

Reference Books:

1. Workshop Technology, Part 1, W.A.J. Chapman, 5th edition, ISBN 9780415503020.
2. Engineering Practices Lab Manual, T. Jeyapoovan & M. Saravanapandian, Vikas Publishing House Pvt. Limited, 4th edition, ISBN: 8125929037.
3. Engineering Practices Laboratory Manual, Ramesh Babu. V., VRB Publishers Private Limited, Chennai, Revised edition, 2019-20, ISBN: 978-81-935993-8.

Web Links:

1. https://bharatskills.gov.in
2. https://www.gopracticals.com/basic-engineering/workshop/

Modern **Physics**
(Common to EEE, ECE, CSE, IT, AIML & CSE (DS))

Course Code:2501PH02

L	T	P	C
2	0	1	3

Course Outcomes:
At the end of the Course, Student will be able to:

CO1 Apply the principles of interference and diffraction to design and enhance the resolving power of grating
CO2 Familiarize the concepts of LASER's and Optical fibres with applications.
CO3 Explain the fundamental concepts of Quantum behavior of matter
CO4 Differentiate various electron theories to understand the properties of solids.
CO5 Explain the basic concepts of Semiconductors and identify the type of semiconductors using Hall effect.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	-	-	-	1	1	-	-
CO2	2	1	-	-	-	-	-	1	1	-	-
CO3	2	1	-	-	-	-	-	1	1	-	-
CO4	2	1	-	-	-	-	-	1	1	-	-
CO5	2	1	-	-	-	-	-	1	1	-	-

Unit–I Wave Optics
Interference: Introduction - Principle of Superposition - Interference of light- Conditions for sustained Interference- Interference in thin films (reflected geometry) – Colours in thin films – Newton's Rings (reflected geometry) – Determination of wavelength and refractive index – Applications.
Diffraction: Introduction – Fresnel and Fraunhofer Diffraction - Diffraction due to Single slit (quantitative), Double slit (qualitative) - N–Slits Intensity distribution curves (qualitative) – Grating spectrum–Rayleigh's criterion - Resolving powers of grating (qualitative) - Applications.

Practice:
1. Determination of Radius of curvature of a pl1ano-convex lens using Newton's Rings.
2. Measurement of Width or thickness of a thin wire by forming interference fringes.
3. Determination of Wavelength of light source using Diffraction grating by normal incidence method.
4. Resolving power of grating.
5. Determination of wavelength of light by using prism.

Unit–II Lasers & Optical Fibers

Lasers: Introduction - Characteristics of Lasers – Spontaneous and Stimulated emission of radiation – population inversion- Einstein's coefficients – Relation - significance - Pumping Mechanisms - Ruby laser – Helium-Neon laser - Applications.
Optical Fibers: Introduction – Principle of propagation in Optical Fiber – Angle of acceptance – Expression for Numerical Aperture and condition for propagation – Classification of Optical fibers - Applications.

Practice:
1. Determination of Wavelength of He-Ne laser source by using diffraction grating.

Unit–III Quantum Mechanics
Introduction – Matter waves – de Broglie's hypothesis – Davisson and Germer Experiment - Heisenberg's Uncertainty Principle – interpretation of wave function – Schrödinger Time dependent and Time Independent wave equations– Particle in a potential box.

Unit–IV Free electron Theory
Free Electron Theory: Introduction–Classical free electron theory (merits and demerits only)
-Quantum Free electron theory – Electrical conductivity- Fermi energy state–Fermi Dirac distribution function - Temperature dependence – Density of states.
Band theory of solids: Bloch Theorem – Origin of energy bands in crystalline solids – classification of crystalline solids.

Practice:
1. Study the variation of magnetic field along the axis of a circular coil carrying current by using Stewart and Gee's apparatus.
2. Determination of Frequency of electrically maintained tuning fork by Melde's apparatus.

Unit–V Semiconductor Physics

Semiconductors Introduction – Intrinsic semiconductors – density of charge carriers (Qualitative only) – Electrical conductivity –Fermi level - extrinsic semiconductors - P-type & N-type semiconductors-Density of charge carriers (Qualitative only) - Dependence of Fermi energy on carrier concentration and temperature–Hall effect-Hall coefficient - Applications of

Hall effect–Drift and Diffusion currents - Einstein's equation
Semiconductor Devices Working of PN junction diode – Forward and reverse bias
Zener diode -Metal-Oxide-Semiconductor (MOS) structure- Capacitance-voltage characteristics- MOSFET structure - I–V characteristics.

Practice:
1. Determination of V-I characteristics and Breakdown voltage of a Zener diode.

2. Determination of Energy band gap of a semiconductor by using P-N junction diode.
3. Study the relation between Temperature and resistance and finding the constants A & B of a thermistor.
4. Determine the resistivity of a semiconductor by four probe method.

Text books:

1. "Engineering Physics" by M N Avadhanulu & T.V.S. Arun Murthy, S Chand &Company Ltd, 1st edition 2024. ISBN: 978-93-5870-932-3
2. "Engineering Physics" by Satyendra Sharma and Jyotshna Sharma, Pearson publications.ISBN: 978-81-3151-178-7

Reference Books:

1. "Concepts of Modern Physics" Authur Beiser, Shobhit Mahajan and S Rai Choudhary, McGraw Hill (2017). ISBN: 9789351341857
2. "Engineering Physics" by M.R. Srinivasan, New Age international publishers (209). ISBN: 978-1848290501
3. "Optics" by Ajoy Ghatak, 6th Edition McGraw Hill Education, 2017. ISBN: 978-939113590

Web Links:

1. http://nptel.ac.in/courses/122107035/11
2. http://nptel.ac.in/courses/115102023/-
3. https://phet.colorado.edu/en/simulations/category/physics
4. http://physicsgecg.blogspot.in/p/reading-materials.html

Differential Equations & Vector Calculus
(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E)

	L	T	P	C
Course Code:2501MA02	**2**	**1**	**0**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Solve the linear differential equations of first order and apply in various engineering problems.
CO2: Solve the linear differential equations of higher order and apply in various engineering problems.
CO3: Solve the linear partial differential equations
CO4: Calculate the gradient, divergence and curl.
CO5: Compute work done, flux using vector integration

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Ordinary Differential Equations of First Order and First Degree:
Solution of first order linear differential equations, exact differential equations and equations reducible to exact differential equations, Orthogonal Trajectories, Modelling of RL- circuit.
Practice(Using any computational tool): Solving the first order initial value problems using **odesolver** and plot the solution curves.

UNIT – II

Linear Differential Equations of Higher Order:
Solution of linear differential equations with constant coefficients, method of variation of parameters, solution of simultaneous linear differential equations.
Equations reducible to Linear differential equations with constant coefficients: Cauchy's homogeneous Linear Equations, Legendre's Linear Equations. Study of oscillations arising in LCR circuit (free oscillations and forced oscillations).
Practice(Using any computational tool): Solving the second order initial value problems using **odesolver** and plot the solution curves

UNIT – III

Partial Differential Equations:
Solution of linear PDE of first order by Lagrange's method, solution of homogeneous linear PDE of higher order with constant coefficients.

UNIT – IV

Vector Differentiation:
Gradient of a scalar field, finding angle between two surfaces, directional derivative. Divergence and solenoidal fields. Curl and irrotational fields, Finding Scalar Potential.
Practice(Using any computational tool): Plotting of surfaces, 3D-plots, plotting vector fields

UNIT – V

Vector Integration:
Line integrals, work done by a force, conservative force field, surface integral, flux, volume integral. Green's theorem, Stoke's theorem and Gauss divergence theorem.

Students are advised to use any computational / AI Tool like Wolfrum Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

Text Books:

1. Advanced Engineering Mathematics, E. Kreyszig, John Willey & Sons,10th Ed., 2018.ISBN978-0470458365
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44'th Edition (2021).ISBN 978-9383214204

Reference Books:

1. Advanced Engineering Mathematics, Dennis G. Zill, Jones & Bartlett Learning, 2018, 6th Edition.ISBN978-1284105902.
2. Higher Engineering Mathematics, B.V. Ramana, McGraw-Hill Education, 11'th Ed., 2017.ISBN 978-9339216016.

Web Links:

1. https://www.classcentral.com/course/differential-equations-engineers-13258
2. https://archive.nptel.ac.in/courses/111/106/111106100/
3. https://www.khanacademy.org/math/differential-equations
4. https://archive.nptel.ac.in/courses/111/101/11111153/
5. https://archive.nptel.ac.in/courses/111/105/111105122/

Electromagnetic Theory

	L	T	P	C
Course Code:2501EE02	**2**	**1**	**0**	**3**

Course Outcomes:

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

CO1	Apply the laws of Electrostatics to calculate electric field intensity.
CO2	Analyze the behaviour of conductors, dielectrics & capacitors.
CO3	Apply the laws of Magneto-statics to calculate field intensity.
CO4	Explain the Self & Mutual inductances & energy stored in the magnetic field using laws of magneto-statics.
CO5	Analyze the concepts of Faraday's laws, displacement current & poynting vector.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	1
CO2	-	1
CO3	-	1
CO4	-	1
CO5	-	1

UNIT – I

Review of Coordinate systems & vector calculus

Electrostatics : Coulomb's Law, Electric field intensity – Field due to the continuous line, surface, & volume charges - Electric flux density – Gauss Law , Maxwell's first law i.e., div(D)=ρv, Potential & potential gradient, Electric Dipole, Laplace and Poisson's equations

UNIT – II

Electrostatic boundary conditions : Current and Current Density, Dipole moment, Behavior of conductors in an electric field – Conductors & Insulators. Polarization - Boundary conditions between conductor to dielectric & dielectric to dielectrics,

Capacitance of parallel plate & coaxial cable -Energy stored & energy density in a static electric field.

UNIT – III

Magnetostatics : Biot-Savart‟s law ,Magnetic field intensity. Magnetic scalar & vector potentials, Maxwell‘s second Equation i.e., div(B)=0, Ampere's circuital law, Maxwell‘s third equation i.e., Curl (H)=J.

Magnetostatic Force : Force on a moving charge (Lorentz force), Force on a straight and a long current carrying conductor in a magnetic field – Force between two straight long and parallel current carrying conductors.

UNIT – IV

Inductance & mutual inductance: Determination of self-inductance of a solenoid and Toroid, mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

UNIT – V

Time-varying Electromagnetic field : Faraday's law, Lenz's law, Maxwell's fourth equation i.e., Curl (E)=-∂B/∂t, Statically and Dynamically induced EMFs, Maxwell's equations in point & integral forms.

Displacement current – Poynting Theorem and Poynting vector.

Text Books:

1. Engineering Electromagnetics,William Hayt & John Buck, 9th edition, Tata McGraw Hill, New Delhi, India, 2020 (ISBN: 978073380667).
2. Elements of Electromagnetics, Mathew O Sadiku, 7th edition, Oxford University Press, New York, USA, 2018(ISBN: 9780190698614).

Reference Books:

1. Field and Wave Electromagnetics,D K Cheng, 2nd edition revised, Pearson Education, Noida, India (ISBN: 9789332535022).
2. Introduction to Electrodynamics, David. J. Griffiths, 4th edition, Pearson Education, Noida, India (ISBN: 978109397759).

Web Links:

1. https://nptel.ac.in/courses/108106073/
2. https://ocw.mit.edu/courses/8-311-electromagnetic-theory-spring/

Electrical Network Analysis-I

	L	T	P	C
Course Code:2501EE03	**2**	**0**	**2**	**4**

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

- **CO1** Make use of network elements, types of sources, source transformation, mesh & nodal analysis for Electrical Circuits.
- **CO2** Analyze the behavior of RLC networks.
- **CO3** Apply the principles of network theorems to solve the electrical circuits.
- **CO4** Determine the resonant frequency & Q factor of an AC Circuit.
- **CO5** Identify magnetic circuits with various dot conventions.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1		2				1	1	
CO2	3	2	1						1	1	
CO3	3	2	1	2					1	1	
CO4	3	2	1						1	1	
CO5	2	1	1						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2	1	
CO3	1	
CO4	1	
CO5	1	

UNIT – I

Introduction to Electrical Circuits : Basic Electrical circuit elements and their V-I relations, Ohm's Law and its limitations, Types of Sources, kirchhoff's laws, network reduction techniques - source transformation technique, nodal analysis, mesh analysis.

PRACTICE:

1. Verification of ohm's law, KCL and KVL using simulation.

UNIT – II

AC Fundamentals: Concepts of AC circuits – RMS value, average value, form factor and peak factor, steady state analysis of RLC circuits, phasor diagrams – real & reactive power, power factor.

Graph Theory: Graph of a network, Incidence matrix, Cutset and Tieset matrices, Dual networks.

PRACTICE:

1. Measurement of Power and Power Factor of RLC Circuit.

UNIT – III

Network Theorems (With AC & DC Excitations): Superposition Theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem, Tellegen's Theorem, Substitution Theorem. (Including dependent sources).

Practice:

1. Verification of Superposition theorem.
2. Verification of Thevenins & Norton theorem .
3. Verification of Maximum Power transfer theorem.
4. Verification of Reciprocity theorem.
5. Verification of Compensation theorem.

UNIT – IV

Resonance: Resonant circuits - series, parallel, series-parallel circuits – effect of variation of Q on resonance. Relations between circuit parameters- Q, resonant frequency & bandwidth, locus diagrams.

Practice:

1. Determination of resonance frequency, Bandwidth, and quality factror of Series & parallel RLC circuit.
2. Draw Locus diagrams of RL and RC series circuit.

UNIT – V

Magnetic Circuit : Basic definition of Magneto Motive Force, flux and reluctance. Analogy between electrical & magnetic circuits. Faraday's laws of electromagnetic induction, concept of self and mutual inductance. Dot convention, coefficient of coupling, composite magnetic circuit-Analysis of series and parallel magnetic circuits.

Practice:

1. Determination of choke coil parameters.
2. Determination of self, mutual inductance, and coefficient of coupling.

Capstone Project:

Design a series or parallel RLC resonant circuit that can be tuned to a specific frequency range. This could be for an AM/FM radio receiver's tuning stage, a band-pass/band-stop filter, or a sensor application where resonance is used to detect changes (e.g., metal detection, simple proximity sensor).

Text Books:

1	Circuit Theory (Analysis & Synthesis) by A. Chakrabarthi, Dhanpat Rai & Co (ISBN: 978817700009).
2	Electrical circuit analysis by A.Sudhakar & Shyammohan S Palli, Mc Graw Hill (ISBN: 9789339219604).

Reference Books:

1	Fundamentals of Electrical Circuits by Charles K.Alex&er & Mathew N.O.Sadiku, Mc Graw Hill Education (India) (ISBN: 978078028229).
2	Electric Circuits–(Schaum's outlines) by Mahmood Nahvi & Joseph Edminister, Adapted by K.UmaRao, 5th Edition – Mc Graw Hill (ISBN-13: 97812611968).

Web Links:

1	http://www.nptelvideos.in/2012/11/circuit-theory.html
2	https://www.youtube.com/user/nptelhrd/videos
3	https://en.wikipedia.org/wiki/Network_analysis_(electrical_circuits)

Numerical Methods and Integral Transforms

(Common to EEE, Min. E & PT)

	L	T	P	C
Course Code:2501MA05	**2**	**1**	**0**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Apply numerical methods to solve the solution of equations and interpolation of polynomials.
CO2: Apply numerical methods to solve problems involving differentiation, integration and initial value problems.
CO3: Compute Fourier series of a function.
CO4: Compute the Fourier transform of a function.
CO5: Apply Laplace transform to solve initial value problems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									
CO5	3	2									

UNIT – I

Solution of Algebraic and Transcendental Equations and Interpolation:
Solution of Algebraic and Transcendental Equations: Errors in Numerical Computation, Bisection method, Method of false position, Secant method and Newton - Raphson method.
Interpolation: Unequal Intervals- Lagrange's interpolation, Newton's divided difference formulae, Equal Intervals-Newton's Forward and Backward difference formlae, Central difference, Relation between operators.
Practice(Using any computational tool): Find solution of equations and Newton's forward interpolation.

UNIT – II
Numerical Differentiation, Integration and Solutions of Ordinary Differential Equations:
Numerical Differentiation: Numerical differentiation using Newton's Forward, Backward and Newton's divided difference formula.
Numerical Integration: Simpson's 1/3rd and 3/8th rule.
Numerical solution of ordinary differential equations: Taylor's series method, Euler's methodand Runge-Kutta method (second and fourth order).

Practice(Using any computational tool):Solving problems on above methods.

UNIT – III

Fourier Series: Fourier series of periodic functions,Half-range series, Change of interval and Fourier series in complex form, Parseval's formula and R.M.S Value.

Practice(Using any computational tool): Generating Fourier Series of functions .

UNIT – IV

Fourier Transforms: Fourier integral theorem (without proof), Fourier sine and cosine integral, Fourier Transform, Properties, Fourier sine and cosine transforms and Finite Fourier transforms.

UNIT – V

Laplace Transforms : Laplace Transform of Standard functions, Properties, Inverse Laplace transform, Properties, Convolution theorem, Solving ordinary differential equations and Simultaneous equations with constant coefficients by using Laplace Transforms.

Practice(Using any computational tool): Finding Laplace Transform of functions.

Students are advised to use any computational / AI Tool like Wolfrum Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 5th Edition (9th reprint), 2021· ISBN978-8184875607
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44'th Edition (2021).ISBN 978-9383214204

Reference Books:

1. Advanced Engineering Mathematics with MATLAB, Dean G. Duffy, CRC Press.ISBN978-1498739641
2. Higher Engineering Mathematics, H. K. Dass, Er. R. Verma, S-Chand publishers, 3rd edition 2023.ISBN 9788121938907

Web Links:

1. https://swayam.gov.in/nd1_noc19_ma21/preview
2. https://onlinecourses.nptel.ac.in/noc20_ge20/preview
3. https://onlinecourses.nptel.ac.in/noc23_ma43/preview
4. https://onlinecourses.nptel.ac.in/noc22_ma62/preview

DC Machines & Transformers

	L	T	P	C
Course Code:2501EE04	**2**	**0**	**2**	**4**

Course Outcomes:

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

- **CO1** Explain the concepts of electromechanical energy conversion and operation of the DC machines.
- **CO2** Analyze starting methods and speed control of DC machines.
- **CO3** Analyze the performance of DC machines by conducting various tests on DC machines.
- **CO4** Analyze the performance of single-phase transformers.
- **CO5** Explain the connections of three phase transformers, Scott connection and tap changers.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2							1	1	
CO2	2	3	2						1	1	
CO3	3	2	2						1	1	
CO4	3	2							1	1	
CO5	2	3	2						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2		1
CO3		1
CO4		1
CO5		1

UNIT – I

Electromechanical Energy Conversion & Introduction to DC machines: Principles of Energy conversion, singly excited and multi excited systems, torque production in rotating machines and general analysis of electromechanical system.

DC Generator: Construction, principle of operation, EMF equation, Types, Armature reaction, Characteristics, Applications.

PRACTICE:

1. Draw open circuit characteristic curves of a given DC shunt generator & to find critical speed & critical field resistance.
2. Draw the internal & external characteristic curves of the given DC Shunt generator by conducting load test.

UNIT – II

DC Motors: Principle of operation, Types, Back EMF, Torque equation, Characteristics, Losses, Efficiency, Commutation, Applications, 3 point starter, 4 point starter, Speed control methods.

PRACTICE:

1. Speed control of a DC shunt motor by field control and armature control method.

UNIT – III

Testing of DC Machines & Single-phase Transformers: Testing of DC machines: Brake test, Swinburne's test, Hopkinson's test, retardation test, field test, separation of losses.
Single-phase Transformers: Types, constructional details, principle of operation, EMF equation, equivalent circuit, operation on no-load and on load, phasor diagrams of transformers.

Practice:

1. Draw the performance curves of the DC shunt motor by conducting brake test.
2. Determine the efficiencies of two identical shunt machines by conducting regenerative test (Hopkinson's test).
3. Predetemine the efficiency of DC shunt machine.
4. Separation of the losses in DC shunt motor.

UNIT – IV

Performance & Testing of Transformers: Performance of Transformers: Regulation, losses and efficiency, effect of variation of frequency and supply voltage on losses, Allday efficiency.
Tests on single phase transformers – open circuit and short ciruit tests.

Practice:

1. Perform OC & SC tests on a single phase transformer and evaluate efficiency, Regulation. Draw the equivalent circuit.

2. Conduct sumpner's test on a two identical single phase transformers and obtain copper losses, core losses and efficiency.

UNIT – V

Three Phase Transformers: Polyphase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ & open Δ, Parallel operation of 3 phase transformers, third harmonics in phase voltages – three winding transformers–off load & on load tap changers, Scott connection, Switching in transients, inrush current.

Additional Practice:

1. Draw the internal & external characteristic curves of the given DC cumulative and differential compound generators by conducting load test.
2. Load test on single phase transformer.
3. Draw the internal & external characteristic curves of the given DC Series Generator by conducting load test.
4. Scott connection on two 1- Ø transformers.

Capstone Project: Design and Performance Analysis of a Small-Scale DC Motor/Generator System

Description: Designing a conceptual small-scale DC motor or generator for a specific application (e.g., a simple electric vehicle prototype, a wind turbine generator). Students would determine the key design parameters, analyze its performance characteristics, and propose methods for control.

Text Books:

1 Electrical Machinery by P.S. Bhimbra, R.C. Khanna & Vineet Khanna, 1st edition, 2021 (ISBN: 9788174091734).

2 DC Machines & Transformers by Dr. K.N. Srinivas, Khanna Publishers, 1st edition, 2022 (ISBN: 9789392549199).

Reference Books:

1 Electrical Machines by D. P. Kothari, I. J. Nagarth, McGraw Hill Publications, 5th edition (ISBN: 978070699670).

2 Electrical Machines by R. K. Rajput, Lakshmi publications, 5th edition (ISBN: 9788131807460).

Web Links:

1 http://nptel.ac.in/courses/108106071

2 http://www.ncert.nic.in/html/learning_basket/electricity/electricity/machine/machi ne_content.htm

3 https://lecturenotes.in/subject/41/electrical-machine-1

Electrical Network Analysis-II

	L	T	P	C
Course Code:2501EE05	**2**	**0**	**2**	**4**

Course Outcomes:

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

- **CO1** Analyze the three phase circuits with Star and Delta connected balanced and unbalanced loads
- **CO2** Analyze the transient behaviour of electrical networks for DC excitation.
- **CO3** Analyze the transient behaviour of electrical networks for AC excitation.
- **CO4** Determine the parameters of given two port networks
- **CO5** Develop electrical networks into different forms.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	-
CO2	1	-
CO3	1	-
CO4	1	-
CO5	1	-

UNIT – I

Three Phase circuits: Phase sequence – star and delta connection-relation between line, phase voltages and currents - analysis of balanced three phase circuits - measurement of active and reactive power. Analysis of three phase unbalanced circuits: Star-Delta transformation technique, Millman's Theorem, Two wattmeter method of 3 phase power measurement.

Practice:

1. Measurement of Reactive Power using one wattmeter method.
2. Measurement of Active Power for Star and Delta connected balanced loads.
3. Measurement of Active Power for Star and Delta connected unbalanced loads.

UNIT – II

Transient Analysis in DC circuits: Transient response of RL , RC and RLC circuits for DC excitation, Solutions using Differential equations and Laplace Transforms.

Practice:

1. Simulation of Transient Response of Series RLC Circuits with Step voltage input for under damp, critically damp and over damp cases.
2. Simulation of Transient Response of series RL and RC circuits with step voltage.

UNIT – III

Transient Analysis in AC circuits : Transient response of R – L , R – C & R – L – C circuits for AC excitation, Solutions using Differential equations & Laplace Transforms.

Practice:

1. Simulation of Transient response of Series RLC Circuit with Sinusoidal Input

UNIT – IV

Two Port Networks : Two Port network parameters - Z, Y, ABCD & Hybrid parameters & their relations, Cascaded networks. Poles & zeros of network functions.

Practice:

1. Calculation of Z parameters of a given two port network.
2. Calculation of Y parameters of a given two port network.
3. Calculation of ABCD of a given two port network.
4. Calculation of h-parameters of a given two port network.

UNIT – V

Network Synthesis : Positive real functions, Hurwitz polynomials, Realization of passive RL, RC & LC Networks using Foster & Cauer forms.

Additional Practice:

2. Simulation of Transient Response of series RL & RC circuits with Sinusoidal Input.
3. Verification of the Milliman's theorem.
4. Simulation of Transient Response of Series RLC Circuits Using Pulse Input

Capstone Project: Smart Home Energy Management System with Unbalanced Load Balancing

Design a conceptual system for a "smart home" that includes various single-phase and three-phase loads, potentially leading to an unbalanced load on the mains. The project would

involve real-time monitoring (simulated) of load conditions and suggesting or dynamically adjusting phases/loads to maintain balance and optimize power consumption.

Text Books:

1 Fundamentals of Electric Circuits by Charles K.Alex&er, Matthew N.O.Sadiku, McGraw-Hill Publications (ISBN: 978078028229).
2 Engineering Circuit Analysis by Hayt, W.H, Kemmerly J.E. & Durbin, Mc Graw Hill Publications (ISBN: 978073529578).

Reference Books:

1 Electric Circuits Schaum's Outline Series, Joseph. A.Edminister, McGraw Hill Publications (ISBN: 978071393072).
2 Network Analysis & Synthesis, Ravish R Singh, McGraw-Hill publications (ISBN: 9789353166724).

Web Links:

1 https://en.wikipedia.org/wiki/Network_analysis_(electrical_circuits)
2 https://nptel.ac.in/courses/108/105/108105159/
3 https://nptel.ac.in/courses/108/104/108104139/

Complex Variables& Statistical Methods

(Common to EEE, PT, Min.E)

	L	T	P	C
Course Code:2501MA06	**2**	**1**	**0**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Examine the continuity and analyticity of functions of complex variables and Evaluate different types of complex integrals

CO2: Expand a function of complex variable as Taylor and Laurent series and evaluate residues.

CO3: Apply various Probability distributions for both discrete and continuous random variables.

CO4: Compute mean and variance of sample means with replacement and without replacement and estimating maximum errors

CO5: Apply various tests to test the hypothesis concerning mean, Proportion, variance.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Functions of a complex variable and Complex integration:
Introduction – Continuity – Differentiability – Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne – Thompson method.
Complex integration: Line integral –Cauchy's integral theorem–Cauchy's integral formula (without proofs)

UNIT – II

Series expansions and Residue Theorem:
Radius of convergence–Expansion in Taylor's series,Maclaurin's series and Laurent series.
Types of Singularities:Isolated–Essential–Pole of order m–Residues–Residue theorem (without proof)

UNIT – III

Random variables and Distributions:
Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution

functions – Mathematical Expectation and Variance –Binomial, Poisson and Normal distributions.
Practice(Using any computational tool): Fitting Binomial and Poisson distributions

UNIT – IV

SamplingTheory:
Introduction –Population and Samples–Sampling distribution of Means and Variance – Central limit theorem (without proof) –Point and Interval estimations –Maximum error of estimate.
Practice(Using any computational tool): Plotting of confidence intervals

UNIT – V

Tests of Hypothesis:
Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors –Level of significance – One tail and two-tail tests – tests for large samples (Z - test for single mean, difference of means, single proportion, difference of proportions) – tests for small samples (t-test for single mean and difference of means)– F-test for comparison of variances-Chi Square test for attributes.
Practice(Using any computational tool):F- test and t- test.

Students are advised to use any computational / AI Tool like Wolfrum Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

Text Books:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44'th Edition (2021).ISBN 978-9383214204
2. Miller and Freund's, Probability and Statistics for Engineers, 9/e, Pearson, 2020.ISBN978-9353945237

Reference Books:

1. Complex Variables and Applications, J.W.Brown and R.V.Churchill, 9th edition , Mc-Graw Hill, 2021 .ISBN 978935460364.
2. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K.Kapoor, 12th edition, Sultan Chand & Sons Publications, 2020.ISBN 978-9351611738

Web Links:

1. https://archive.nptel.ac.in/courses/111/103/111103070/
2. https://onlinecourses.nptel.ac.in/noc20_ma50/preview
3. https://onlinecourses.nptel.ac.in/noc21_ma74/preview
4. http://mathworld.wolfram.com/topics/ProbabilityandStatistics.html
5. https://www.khanacademy.org/math/statistics-probability

Electric Power Generation & Distribution Systems

	L	T	P	C
Course Code:2501EE06	**2**	**0**	**0**	**2**

Course Outcomes:

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

CO1	Identify the different components of various power plants.
CO2	Distinguish between AC/ DC distribution systems & also estimate voltage drops of distribution systems.
CO3	Classify the different components of air & gas insulated substations.
CO4	Analyze single core & multi core cables with different insulating materials.
CO5	Analyze the different economic factors of power generation & tariffs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1				2					
CO2	2	3	1								
CO3	2	1	3			1					
CO4	2	3	1			1					
CO5	2	3	1								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	1	1
CO3	1	1
CO4	1	
CO5	1	1

UNIT – I

Power Stations: Principle of power generation, site selection, Components and layout of Thermal, Nuclear, Hydro power plant.

UNIT – II

Distribution Systems: Classification, radial distribution, ring main distribution, Design features, Voltage drop calculations: Radial DC distributor fed at one end & at both ends (equal / unequal voltages), Ring main distributor, stepped distributor & AC distribution, comparison of DC & AC distribution.

UNIT – III

Air & Gas Insulated Substations: Indoor & Outdoor substations, Substations layouts of 66/11 kV, Types of Bus bar arrangements in the Sub-Stations. Types, installation, maintenance, construction, advantages of GIS, Comparison of Air & Gas insulated substations.

UNIT – IV

Underground Cables: Types of Cables, Construction, Types of insulating materials, Calculation of insulation resistance, stress in insulation & power factor of cable. Capacitance of single & 3- Core belted Cables, Grading of Cables-Capacitance grading.

UNIT – V

Economic Aspects of Power Generation & Tariff Methods:
Types of load, Load curve, load duration & integrated load duration curves, Important terms & factors in Load Curve. Costs of Generation & their division into Fixed, Semi-fixed & Running Costs, Characteristics & types of Tariff.

Text Books:

1. A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar &, A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd (ISBN: 978817700207).
2. Generation, Distribution & Utilization of Electric Energy by C. L. Wadhawa, Newage International (P) Limited, Publishers (ISBN: 9789393159175)..

Reference Books:

1. Principles of Power System by V. K. Mehta & Rohit Mehta, S Chand & Company Limited, Publishers (ISBN: 9788121924962).
2. Electrical Power Distribution Systems by V. Kamaraju, Tata McGraw Hill, New Delhi (ISBN: 978070151413).

Web Links:

1. https://www.slideshare.net/ntpc-project-korbasuper-themal-power-plant
2. https://www.euronuclear.org/1-information/energy-uses.htm
3. https://www.slideshare.net/9anku/electrical-distribution-system

Induction & Synchronous Machines

Course Code:2501EE07	L	T	P	C
	2	0	2	4

Course Outcomes:

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

CO1	Analyze the performance of induction motors & induction generator.
CO2	Apply the methods of starting & speed control of Three phase Induction Motors
CO3	Analyze the performance of synchronous generator.
CO4	Analyze the Parallel operation of synchronous generators.
CO5	Explain hunting phenomenon, implement methods of starting & correction of power factor with synchronous motor.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	1						1	1	
CO2	3	2	1						1	1	
CO3	2	3							1	1	
CO4	2	3	1						1	1	
CO5	2	3	1						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2		1
CO3		1
CO4		1
CO5		1

UNIT – I

Three Phase Induction Motors: Construction and types, concept of rotating magnetic field, principle of operation, rotor emf and rotor frequency, rotor current and pf at stand still and running conditions, rotor power input, rotor copper lossess, mechanical power developed and their interrelationship, equivalent circuit, phasor diagram. Torque equation – expressions for maximum torque and starting torque, torque slip characteristic, double cage and deep bar rotors, crawling & cogging.

UNIT – II

Starting & Testing of Induction Motors: Speed control of induction motor with V/f method, no load and blocked rotor tests, circle diagram for predetermination of performance, methods of starting, starting current and torque calculations, induction generator operation (Qualitative treatment only).
Single phase induction motors: Concept of starting, Double revolving field theory, Types, equivalent circuit, Shaded pole motors, AC Series motor.

Practice:

1. Performance characteristics of a three- phase Induction Motor by conducting Brake test.
2. Determination of equivalent circuit parameters, efficiency & regulation of a three phase Induction motor by conducting No–load & Blocked rotor tests.
3. Speed control of three phase induction motor by V/f method.
4. Determination of equivalent circuit parameters of single phase induction motor.
5. Determination of efficiency of a single-phase Induction Motor by conducting Brake test.

UNIT – III

Synchronous generator: Operation, Construction,Types of Armature windings, Distribution, Pitch and winding factors, E.M.F equation, armature reaction, Voltage regulation by synchronous impedance method, MMF method and Potier triangle method, Two reaction theory, Slip test.

Practice:

1. Determination of Regulation of a three–phase alternator by using synchronous impedance method.
2. Determination of Regulation of a three–phase alternator by using M.M.F. method.
3. Determination of Regulation of a three–phase alternator by using Potier triangle method.
4. Determination of efficiency of three-phase alternator by loading with three phase induction motor

UNIT – IV

Parallel Operation of Synchronous Generators: Parallel operation with infinite bus & other alternators, Power flow equations, Synchronizing power, Load sharing, Control of real and reactive power.

UNIT – V

Synchronous Motor: Principle of operation, Starting torque, Variation of current and power factor with excitation, Synchronous condenser, mechanical power developed, Hunting and its suppression, Methods of starting, applications.

Practice:

1. Determination of V and Inverted V curves of a three phase synchronous motor.

Additional Practice:

1. Synchronize the Alternator to infinite bus by using dark lamp method
2. Determine the Efficiency of 3 phase alternator by loading with 3 phase resistive load
3. Determination of X_d & X_q of a salient pole synchronous machine

Capstone Project:

Simulate the Model two (or more) synchronous generators operating in parallel to supply a common load, possibly connected to an infinite bus or operating as an isolated microgrid. Focus on the control strategies for sharing real and reactive power among the generators. Investigate the effects of excitation and prime mover control on load sharing and system stability.

Text Books:

1 Electrical Machinery by P.S. Bhimbra, R.C. Khanna & Vineet Khanna, 1st edition, 2021 (ISBN: 9788174091734).

2 Electrical Machines by R. K. Rajput, Lakshmi publications, 5th edition (ISBN: 9788131807460).

Reference Books:

1 Electrical Machines by D. P. Kothari, I. J. Nagarth, McGraw Hill Publications, 5th edition (ISBN: 978070699670).

2 Electrical Machinery by Abijith Chakrabarthi & Sudhipta Debnath, McGraw Hill, 1st edition (ISBN: 978125906456).

Web Links:

1 https//nptel.ac.in/courses/108/105/108105131

2 https://www.electrical4u.com/parallel-operation-of-alternator

3 https://www.electrical4u.com/speed-control-of-three-phase-induction-motor/.

Analog Electronic Circuits

	L	T	P	C
Course Code:2501EE08	**2**	**1**	**1**	**4**

Course Outcomes:

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

CO1	Interpret the characteristics of semiconductor diodes & transistor.
CO2	Explain the characterestics of uncotrolled rectifiers.
CO3	Analyze biasing and small signal low frequency equivalent models of BJT and FET .
CO4	Illustrate the Feedback Amplifiers ,Oscillators and multivibrator.
CO5	Analyze operational amplifier circuits for various linear and non-linear applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	1						1	1	1
CO2	3	2	2						1	1	1
CO3	2	3	2						1	1	1
CO4	2	3	1						1	1	1
CO5	2	1	3						1	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2		1
CO3		1
CO4		1
CO5		1

UNIT – I

Semiconductor devices and characteristics: Review of P-N junction operation, Open circuited PN junction, energy band structure of open circuited PN junction, drift and diffusion currents, law of junction, Breakdown mechanisms, V-I Characteristics, temperature dependence of V-I characteristics, Diffusion and Transition capacitances, Characteristics of Zener diode, regulated power supplies.

Practice:

1. Determination of VI Characteristics of a Diode.

2. Determination of V-I characteristics of Zener diode and Zener Diode-Voltage Regulator

UNIT – II

Uncontrolled Rectifiers: Types of rectifiers & their operation, input & output waveforms, parameters of rectifiers. Single phase half wave, full wave & bridge rectifiers with filters (L, C & π), comparison of various filter circuits in terms of ripple factor. clippers, clampers.

Practice:

1. Calculate the Ripple factor and percentage Regulation of Half-wave Rectifier
2. Calculate the Ripple factor and percentage Regulation of Full-wave bridge

UNIT – III

Transistors and FET: Construction and operation of BJT (3 configurations), FET & MOSFET, Hybrid-π model of transistor, Analysis of CE, CC & CB. Comparison of transistor amplifiers. Transistor biasing & thermal stabilization (self-bias).

Practice:

1. Determine h-parameters of CE Configuration from Input & Output Characteristics.
2. Determine h-parameters of CB Configuration from Input & Output Characteristics.
3. Studies on BJT CE Amplifier

UNIT – IV

Feedback Amplifiers & Oscillators: Classification, feedback concept, transfer gain & general characteristics of negative feedback amplifiers, effect of feedback on input & output resistances. Condition for oscillation, RC-phase shift oscillator.

Practice:

1. Determine the RC Frequency Response of Low pass filter and high pass filter

UNIT – V

Op-Amps: Block Diagram of an Op-Amp IC 741, AC & DC characteristics, Measurement of Op-Amp parameters.
Linear Applications of Op-Amps: Adder, subtractor, integrator, differentiator, & Logarithmic functions.
Non-Linear Applications of Op-Amps: Comparators, Multivibrators, Triangular &Square wave generators, Log & Antilog Amplifiers, Precision rectifiers.

Practice:

1. Study of basic properties of operational amplifier: inverting and non-inverting amplifiers
2. Design an Integrator & Differentiator Circuits using Op-Amp 741.

Additional Practice:

1. Study of voltage comparator.
2. Design astable multivibrator using 555 timer IC.
3. Analyse Function generator using operational amplifier (sine, triangular and square wave).
4. study log and antilog amplifier.

Capstone Project:

Design a circuit that automatically controls lighting based on ambient light intensity. This system would use an LDR as a sensor, a transistor (BJT) or an Op-Amp as a comparator to detect light levels, and a relay driver (using a BJT) to switch an LED or small lamp. The design should include a hysteresis mechanism to prevent rapid on/off switching near the threshold.

Text Books:

1 Electronic Devices & Circuits, R.L. Boylestad & Louis Nashelsky, Pearson Education, 11 th Edition, (ISBN: 9780133757422).

2 Electronic Devices & Circuits, Jacob Millman & Christos Halkias black edition , Tata McGraw Hill, 2018 (ISBN: 9789339219543).

Reference Books:

1 Electronic Devices & Circuits, David A. Bell, Oxford University Press, 5th Edition, (ISBN: 9780195693409).

2 Design with Operational Amplifiers analog Integrated Circuits, Sergio Franco, 4E, McGraw-Hill series (ISBN: 978070217997).

Web Links:

1 https://drmcet.digimat.in/nptel/courses/video/11711106/L23.html

2 https://drmcet.digimat.in/nptel/courses/video/108102095/L01.html

Digital Electronics & Logic Design

(Common to EEE & ECE)

	L	T	P	C
Course Code:2501EC01	**2**	**0**	**2**	**4**

Course Outcomes:

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

- **CO1:** Interpret number representation in different code formats and the functionality of Logic Gates.
- **CO2:** Perform logic minimization using suitable techniques.
- **CO3:** Design various combinational logic circuits for required specifications.
- **CO4:** Design different sequential logic circuits.
- **CO5:** Implement logic functions using PLDs.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	3
CO4	-	3
CO5	-	3

UNIT – I

Number Systems: Representation of numbers of different radix, conversion from one radix to another radix, r-1's compliment and r's compliment of signed numbers, problem solving. Binary Codes: 4bit codes, 2421, 8421. Error detection & correction codes, (parity checking, even parity, odd parity), Review of logic gates.

Practice:

1. Functional verification of logic gates.
2. Develop basic logic gates using universal gates.

UNIT – II

Boolean Algebra & Minimization Techniques: Boolean theorems, principle of complementation & duality, De-Morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 5 variables, tabular minimization.

Practice:

1. Verification of De-Morgan's laws.
2. Design a logic circuit for a given Boolean expression.

UNIT – III

Combinational logic circuits: Review of adders, half subtractor, full subtractor, ripple carry adder, carry look-a-head adder circuit, 4-bit binary adder/subtractor circuit, BCD adder, Decoders, encoders, multiplexers, de-multiplexers, comparators and code converters, realization of Boolean functions using decoders & multiplexers.

Practice:

1. Design Full adder circuit and verify its truth table.
2. Design a combinational logic circuit for 8 to 1 MUX.
3. Verification of functional table of 3-to-8-line Decoder/De-multiplexer.
4. Design BCD to Seven Segment Display Decoder.

UNIT – IV

Sequential Circuits: Latches and flip flops, truth tables and excitation tables, flipflop with reset and clear, Conversion of flip-flops. Design of registers - shift register, bi-directional shift register, universal shift register, Design of ripple counters, design of synchronous counters, Johnson counter, ring counter.

Practice:

1. Verify the truth tables of Basic Flip-flops.
2. Design an 8-bit right shift register using D Flip-flop and verify the truth table.

UNIT – V

Programmable Logic Devices: Introduction to PLDs: PROM, PAL, PLA-Basics structures, realization of Boolean function with PLDs, programming tables of PLDs, merits & demerits of PROM, PAL, PLA comparison, realization of Boolean functions using PROM, PAL, PLA.

Additional Practice:

1. Design an Experimental model to demonstrate the operation of74154 De-Multiplexer. using LEDs for outputs
2. Design BCD Adder Circuit and Test the Same using Relevant IC.
3. Verify the operation of 4-bit Universal Shift Register for different Modes of operation.

Capstone project:

1. Binary Calculator (4-bit)
   Description:
   Design a simple calculator that can perform **binary addition, subtraction, AND, OR** using switches and LEDs. (Optional Extension: Use a 7-segment display to show results)

Text Books:

1. Switching and Finite Automata Theory, ZviKohavi& Niraj K.Jha, 3rdEdition, ISBN: 978-0521857482.
2. Digital Design, Morris Mano, Pearson, 3rd Edition, ISBN: 978-8178085555.

Reference Books:

1. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 5thEdition, 2022, ISBN: 978-9355321770.
2. Fundamentals of Logic Design, Charles H. Roth Jr., Jaico Publishers,2ndEdition, ISBN: 978-0534378042.

Web Links:

1. http://nptel.ac.in/courses/117/106/117106086/
2. www.nptelvideos.in/2012/12/digital-circuits-and-systems.html
3. https://www.smartzworld.com/notes/switching-theory-and-logic-design-stld/

Microprocessor & Interfacing

	L	T	P	C
Course Code:2501EE09	**2**	**1**	**1**	**4**

Course Outcomes:

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

- **CO1** Interpret the generalized concepts of 8085 microprocessors.
- **CO2** Demonstrate programming proficiency using the various addressing modes & instructions of 8086 & distinguish the minimum & maximum mode of operations of 8086 .
- **CO3** Interpret the basic concepts of interfacing memory & peripheral devices to a microprocessor.
- **CO4** Develop the internal architecture of microprocessors systems, including counters, timers, ports, & memory.
- **CO5** Distinguish the circuits for various interfacing using microcontrollers.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	1	1
CO3	1	1
CO4	1	1
CO5	1	1

UNIT – I

Introduction & evolution of Microprocessors : 8-Bit Microprocessor, 8085 architecture & memory interfacing (RAM & ROM), interfacing I/O devices, Instruction set, addressing modes, assembly language programming, interrupts, timing diagram.

Practice:

1. Write program using 8085 & verify for: a.addition of two 8-bit numbers, b.addition of two 16-bit number(with carry).

2. Write program using 8085 & verify for: a.subtraction of two 8-bit number(display of borrow) b. subtraction of two 16-bit numbers(display of borrow).
3. Write an 8085 assembly language program to add two decimal 8-bit numbers using DAA instruction. Store the result in Decimal number system.

UNIT – II

Microprocessor 8086 Architecture & Mode of Operations: Architecture, Memory Organization,Register Organization, Instruction sets, Addressing modes, Assembler directives, General bus operation of 8086, Minimum & Maximum mode operations, Control signal interfacing, Read & write cycle timing diagrams.

Practice:

1. 8 bit & 16 Bit Arithmetic operations using Assembly Language Programming
2. Multi byte addition & subtraction using Assembly Language Programming.
3. Code conversion – Binary to BCD using Assembly Language Programming
4. Sorting an array using Assembly Language Programming

UNIT – III

Peripherals & interfacing : 8255 PPI: Architecture, Modes of operation, Interfacing I/O devices to 8086, Interfacing A to D converters, Interfacing D to A converters, Stepper motor interfacing, Static memory interfacing with 8086.

Practice:

1. Parallel Communication between Two Microprocessors using 8255
2. Interface DAC to 8086 using Intel 8255.
3. Interface stepper motor to 8086.

UNIT – IV

Microprocessors I/O interfacing: Architecture & interfacing of 82501 USART, Architecture & interfacing of 8254 Timer/counter, Architecture & interfacing of DMA controller (8257), Architecture of Keyboard/display controller (8279), Modes of operation

UNIT – V

8051 Microcontroller & interfacing : Overview of 8051 Microcontroller, Architecture, Memory Organization, Register set, I/O ports & Interrupts, Timers & Counters, Serial Communication, LCD interfacing, Keyboard interfacing ADC, DAC & sensor interfacing.

Practice:

1. Interfacing LCD to 8051.
2. Write an ALP to verify timer/counter operation in 8051.
3. Interface ADC 8051 to 8086
4. Write an ALP for Arithmetic, logical & bit manipulation operations in 8051

Capstone Project:

Design a traffic light controller for a four-way intersection using an 8086 microprocessor, leveraging its timer (8254) and interrupt capabilities. The system should cycle through standard traffic light sequences with defined timings for each phase. Incorporate a push-button (external interrupt) for pedestrian crossing request that alters the sequence.

Text Books:

1 Advanced Microprocessor & Peripherals,3rd Edition, By K M. Bhurchandi, A. K. Ray, Tata McGraw Hill Education Private Limited (ISBN: 9781259029776).
2 Microprocessor Architecture, Programming, & Applications with the 8085 By Ramesh S. Gaonkar, Prentice Hall (ISBN: 9780130195708).

Reference Books:

1 Microprocessors & Interfacing - Sie, 3rd Edn, by Douglas V Hall SSSP Rao Douglas V Hall, Mc Graw Hill Education (ISBN: 978070601673).
2 Microcontrollers – Theory & Applications, Ajay V. Deshmukh, Tata McGraw–Hill Education (ISBN: 978070585959).

Web Links:

1 https://archive.nptel.ac.in/courses/108/103/108103157/
2 https://archive.nptel.ac.in/courses/108/105/108105102/
3 https://nptel.ac.in/courses/108103157

Power Electronics

	L	T	P	C
Course Code:2501EE10	**2**	**1**	**1**	**4**

Course Outcomes:

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

- **CO1** Explain the different types of power semiconductor devices & their Characteristics.
- **CO2** Evaluate the performance of rectifiers.
- **CO3** Illustrate the operation of AC voltage controllers & cyclo-converters.
- **CO4** Design DC-DC converter with given characteristics.
- **CO5** Explain the operation of Inverters & application of PWM techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1						1	1	
CO2	2	3	2						1	1	
CO3	3	2	2						1	1	
CO4	2	3	2						1	1	
CO5	3	2	2						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	2	1
CO3	2	1
CO4	2	1
CO5	2	1

UNIT – I

Introduction to Power Electronics devices:
Concept of power electronics, applications, types of power converters, operation & characteristics of Power IGBT, SCR, TRIAC, static & dynamic characteristics of SCR, protection of SCR, turn on methods of SCR & commutation of SCR, Thyristor Firing Circuits.

Practice:

1. Study of Characteristics of Thyristor, MOSFET & IGBT.
2. Design & development of a firing circuit for Thyristor.
3. Design & development of gate drive circuits for IGBT.

UNIT – II

Phase Controlled Converters: Principles of single-phase fully-controlled converter with R, RL, & RLE load, effect of freewheeling diode, Principles of single-phase half-controlled converter with RL & RLE load, Principles of three-phase fully controlled converter operation with RLE load, Effect of source inductance.

Practice:

1. Single -Phase half-controlled converter with R & RL load.
2. Single -Phase fully controlled bridge converter with R & RL loads.
3. Three- Phase fully controlled converter with RL–load.

UNIT – III

AC-AC converters: AC Voltage Controllers: Introduction, principle of operation with R, R-L loads & its applications.
Cycloconverters: Principle of operation of single-phase to single-phase, three-phase to single phase, three-phase to three-phase configurations.

Practice:

1. Single -Phase AC Voltage Regulator with R & RL Loads.

UNIT – IV

DC-DC Converters: Chopper classification, study of Buck, Boost & Buck-Boost regulators, Basic operation of forward & fly back converters.

Practice:

1. Design & verification of voltages gain of Boost converter in Continuous Conduction Mode (CCM).
2. Design & verification of voltages ripple in buck converter in CCM operation.

UNIT – V

Inverters: Principle of operation of single phase bridge inverters with R, RL & RLC loads, Voltage control of single-phase inverters: single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation, 3-phase bridge inverters: 180- & 120-degrees mode of operation.

Practice:

1. Single -phase PWM inverter with sine triangle PWM technique.

Additional Practice:

1. Simulation of Buck, Boost & Buck-Boost converter.
2. Simulation of SPWM controlled Three-phase voltage source inverter.
3. Simulation of 3 phases half & full wave converter with R, RL, RLE & RE loads. plot the waveforms for Voltage across & current through the switch.

Capstone Project:

Design a simplified single-phase or three-phase grid-tied inverter system for a solar photovoltaic (PV) array. The project would focus on the inverter stage (DC-AC conversion) using appropriate power devices (IGBTs) and implement a basic control strategy to achieve a desired AC output that can be synchronized with the grid. Analyze harmonics, efficiency, and power quality.

Text Books:

1	Power Electronics – by P. S. Bhimbra, Khanna Publishers (ISBN:9788174092793).
2	Power Electronics: Circuits, Devices & Applications – by M.H Rashid, Prentice Hall of India, 3rd edition (ISBN: 9788120345317).

Reference Books:

1	Power Electronics: Essentials & Applications by L. Umanand, Wiley, Pvt. Limited, India (ISBN: 9788126519453).
2	Power Electronics, M. D. Singh & K. B. Kanchandhani, Tata McGraw – Hill Publishing Company, 2nd Edition (ISBN: 978074633694).

Web Links:

1	https://nptel.ac.in/courses/108/101/10811038/
2	https://nptel.ac.in/courses/108/102/108102145/
3	https://nptel.ac.in/courses/108/102/108102145/

Control Engineering

	L	T	P	C
Course Code:2501EE11	**2**	**0**	**2**	**4**

Course Outcomes:

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

- **CO1** Determine the overall transfer function using block diagram algebra & signal flow graphs & Mechanical systems
- **CO2** Determine time response specifications of second order systems & analyze the effect of PID controllers & Apply the Routh's stability criterion & the root locus method for stability of LTI systems
- **CO3** Analyze the stability of LTI systems using frequency response methods.
- **CO4** Design & compensation of LTI systems using Bode diagrams
- **CO5** Analyze the state space representations of LTI systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2							1	1	
CO2	2	3	2						1	1	
CO3	2	2	3						1	1	
CO4	2	2	3						1	1	
CO5	2	3	1						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2		1
CO3		1
CO4		1
CO5		1

UNIT – I

Mathematical Modelling of Control Systems : Introduction of open loop & closed loop control systems, Transfer function -Feedback characteristics, differential equations translational & rotational mechanical systems, transfer function of DC servo motor & AC servo motor, block diagram algebra, signal flow graph, reduction using Mason's gain formula.

Practice:

1. Study the characteristics of Synchros - Transmitter & receiver.
2. Draw the speed - torque characteristics of AC servo motor.
3. Draw the speed - torque characteristics of DC servo motor.
4. Study the effect of feedback on DC servo motor.
5. Determine the transfer function of DC motor.
6. Draw the load Characteristics of magnetic amplifiers.

UNIT – II

Time Response & S-Domain Analysis: Time Response Analysis
Standard test signals, time response of first & second order systems, time domain specifications, steady state errors & error constants, effect of PID controllers on systems.
Stability in S-domain:
The concept of stability, Routh's stability criterion, root locus concept, construction of root loci.

Practice:

1. Study the effect of P, PD, PI, PID Controller on a second order systems.
2. Study temperature controller using PID.

UNIT – III

Frequency Response Analysis : Introduction to frequency domain specifications, Bode diagrams, transfer function from the Bode diagram, Polar plots, Nyquist stability criterion, stability analysis.

UNIT – IV

Classical Control Design Techniques: Lag, lead, lag-lead compensators, physical realisation, design of compensators using Bode plots.

Practice:

1. Draw the magnitude & phase plots of lag & lead compensators.
2. Study & verify the truth table of logic gates using PLC.

UNIT – V

State Space Analysis of Linear Time Invariant (LTI) Systems: Concepts of state, state variables & state model, state space representation of transfer function, solving the time invariant state equation, State Transition Matrix & its properties, concepts of controllability & observability.

Additional Practice

1. Simulate Bode plot for the transfer functions of systems up to 3rd order using MATLAB.
2. Simulate Nyquist plots for the transfer functions of systems up to 3rd order using MATLAB.
3. Simulate Root locus for the transfer functions of systems up to 3rd order using MATLAB.
4. Simulate Controllability test using MATLAB.
5. Determine time response of Second order system.

Capstone Project:

Design and simulate a closed-loop control system for a DC servo motor to precisely control its speed and/or angular position. The project would involve deriving the motor's transfer function, designing a PID controller (and potentially a lead-lag compensator for improved performance), and analyzing the system's time domain (rise time, settling time, overshoot, steady-state error) and frequency domain characteristics. Compare the performance with and without the controller.

Text Books:

1	Modern Control Engineering by Kotsuhiko Ogata, Prentice Hall of india (ISBN: 978812034107).
2	Automatic control systems by Benjamin C.Kuo, Prentice Hall of India, 2nd Edition (ISBN-13: 9781259643835).

Reference Books:

1	Control Systems Engineering by I.J.Nagarath & M.Gopal, Newage International Publications, 5th Edition (ISBN: 9788195175581).
2	Control Systems Engineering by Norman S. Nise, Wiley Publications, 7th edition (ISBN: 9781119590132).

Web Links:

1	Control Systems principles & design by M.Gopal, Tata Mc Graw Hill education Pvt Ltd., 4thEdition
2	http://engineering.electrical-equipment.org/panel-building/time-domain-analysis-of-controlsystems.htm
3	http://www.cds.caltech.edu/~murray/amwiki/index.php/Frequency_Domain_Analysis

Electric Power Transmission Systems

	L	T	P	C
Course Code:2501EE12	**2**	**1**	**0**	**3**

Course Outcomes:

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

- **CO1** Determine parameters of transmission lines for different circuit configurations.
- **CO2** Analyze the performance of short, medium & long transmission lines.
- **CO3** Analyze the effect of travelling waves on transmission lines
- **CO4** Identify various factors related to sag & corona.
- **CO5** Demonstrate the different types of Insulators & transmission line effects.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	-
CO2	1	-
CO3	1	-
CO4	1	-
CO5	1	-

UNIT – I

Calculation of inductance & capacitance: Concept of GMR & GMD, single phase and three phase lines with symmetrical & unsymmetrical spacing, with & without transposition, bundled conductors, & effect of earth on capacitance.

UNIT – II

Performance of Lines: Classification of Transmission Lines, model representations, End condenser method, Nominal-T, Nominal-Pie, Rigorous solution and A, B, C, D Constants, regulation and efficiency, Surge Impedance & SIL of Long Lines, Wave Length and Velocity of Propagation of Waves .

UNIT – III

Transients of lines: Types of System Transients Travelling wave or Propagation of Surges, Attenuation, Distortion, Reflection and Refraction Coefficients Termination of lines with different types of conditions, Open Circuited Line, Short Circuited Line, T Junction, Lumped Reactive Junctions.

UNIT – IV

Corona & Sag: Corona, Description of the phenomenon,Factors affecting corona, Critical voltages and power loss, Radio Interference. Sag and Tension calculations with equal and unequal heights of towers, Effect of Wind and Ice on weight of Conductor.

UNIT – V

Insulators & Transmission line effects: Types of Insulators, String efficiency and Methods for improvement, Voltage distribution, Calculation of string efficiency, Capacitance grading and Static Shielding, Skin and Proximity effects, Description and effect on Resistance of Solid Conductors, Ferranti effect, Charging Current.

Text Books:

1	Electrical power systems – by C. L. Wadhwa, New Age International (P) Limited, Publishers. Eighth edition 2022 (ISBN: 9789393159175).
2	Modern Power System Analysis by I. J. Nagarath & D. P. Kothari, Tata McGraw Hill, 5th Edition.2022 (ISBN-13: 978125903172).

Reference Books:

1	A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar A. Chakrabarthy, Dhanpat Rai & Co Pvt. Ltd (ISBN:978817700207).
2	Power system Analysis–by John J Grainger William D Stevenson, TMC Companies (ISBN: 978070612945).

Web Links:

1	https://www.electrical4u.com/performance-of-transmission-line/
2	https://gradeup.co/models-&-performance-of-transmission-lines-&-cables-iebfce936-c584-11e5 baa5-76adddde8c47

Electrical Measurements & Instrumentation

	L	T	P	C
Course Code:2501EE13	**2**	**1**	**1**	**4**

Course Outcomes:

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

- **CO1** Understand different types of instruments for measurement of AC & DC quantities.
- **CO2** Explain different types of instruments for measurement of power & power factor.
- **CO3** Identify suitable bridges for measurement of R, L, & C.
- **CO4** Analyze the effectiveness of Transducers.
- **CO5** Illustrate the principle of different types of Digital Meters.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	0	-	-	-	-	-	-	-
CO2	3	2	1	0	0	-	-	-	-	-	-
CO3	3	2	1	0	0	-	-	-	-	-	-
CO4	2	3	1	0	0	-	-	-	-	-	-
CO5	3	2	1	0	0	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	1
CO2	0	1
CO3	0	1
CO4	0	1
CO5	0	1

UNIT – I

Analog Ammeter & Voltmeters: Classification, Construction of PMMC, Moving Iron and Electrostatic Instruments, deflecting, control and damping torques, Torque equation, Range extension, Errors and compensations.
Instrument transformers: Current and Potential transformers, Construction and Working.

UNIT – II

Measurement of Power & Energy: Electro dynamometer type wattmeter: LPF and UPF, Power factor meters: Dynamometer and MI type (Single phase and Three phase), Single phase induction type energy meters: Construction, theory, torque equation advantages &

disadvantages. Measurement of active & reactive power in single phase & in three phase with balanced loads.
Potentiometers: Introduction to DC & AC Potentiometers – Construction-working.

Practice:

1. Calibration & Testing of single phase energy Meter.
2. Calibration of dynamometer wattmeter using phantom loading.
3. Calibration of PMMC ammeter & voltmeter using Crompton D.C. Potentiometer.
4. Measurement of 3 phase reactive power with single phase wattmeter for balanced Loading.
5. Measurement of 3 phase power with single wattmeter & using two C.Ts.
6. Calibration of LPF wattmeter by direct loading.

UNIT – III

Measurement of Electrical parameters:
DC Bridges - Wheat stone's bridge, Kelvin's double bridge, Loss of charge method, Megger.
AC Bridges - Measurement of inductance and quality factor: Maxwell's bridge, Hay's bridge, Anderson's bridge.
Measurement of capacitance and loss angle: Desauty's bridge, Schering Bridge.

Practice:

1. Measurement of resistance & Determination of Tolerance using Kelvin's double Bridge.
2. Capacitance Measurement using Schering Bridge.
3. Inductance Measurement using Anderson Bridge.

UNIT – IV

Transducers: Definition, Classification, LVDT, Strain Gauge, Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers, Hall effect sensors.

Practice:

1. Determination of the characteristics of a LVDT.

UNIT – V

Digital meters : Digital Voltmeters –Successive approximation DVM, Ramp type DVM and Integrating type DVM, Digital frequency meter, Digital multimeter, Digital tachometer, Digital Energy Meter, CRO- measurement of phase difference and Frequency using lissajious patterns.

Additional practice:

1. Measurement of resistance using Wheatstone bridge.
2. Dielectric oil testing using H.T test Kit.
3. Measurement of Choke coil parameters & single-phase power using three voltmeter & three ammeter method.

Capstone Project:

Design and program a simple digital frequency meter using a low-cost microcontroller (like an Arduino). The microcontroller would count pulses over a fixed time interval and calculate the frequency, displaying it on a small LCD or serial monitor.

Text Books:

1 Electrical Measurements & measuring Instruments by E.W. Golding & F.C.Widdis - 5th Edition - Wheeler Publishing (ISBN: 9780273402022).

2 Modern Electronic Instrumentation & Measurement Techniques by A.D. Helfrick & W.D. Cooper - 5th Edition, PHI (ISBN: 9788120307520).

Reference Books:

1 Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications (ISBN: 978609578337).

2 Electrical & Electronic Measurements & instrumentation by R.K.Rajput (ISBN: 9788121929899).

Web Links:

1 Electrical Measurements by Buckingham & Price - Prentice – Hall

2 https://archive.nptel.ac.in/courses/108/105/108105153/

3 https://electricalbaba.com/different-types-of-transducers/

Power System Anlaysis

	L	T	P	C
Course Code:2501EE14	**2**	**0**	**2**	**4**

Course Outcomes:

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

CO1	Explain the impedance diagram for a power system network and per unit quantities.
CO2	Apply the different load flow methods to solve the power system problems.
CO3	Explain the Formation of Z-bus.
CO4	Evaluate the fault currents for all types faults to provide data for the design of Protective devices.
CO5	Analyze the steady state, transient and dynamic stability concepts of a power system.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	-
CO2	1	-
CO3	1	-
CO4	1	-
CO5	1	-

UNIT – I

Per Unit Representation : Modeling of power system components, single line diagram, Impedance and Reactance diagrams, Per unit quantities, Bus impedance and Admittance matrix.

Practice:

1. Determination of Y bus using direct inspection method.

UNIT – II

Power Flow Studies: Necessity of power flow studies, Gauss-Seidel, Newton-Raphson and Fast decoupled methods.

Practice:

1. Load flow solution of a power system network using Gauss-Seidel method.
2. Load flow solution of a power system network using Newton Raphson method.

UNIT – III

Z-Bus Algorithm: Formation of Z-bus: Algorithm for the Modification of Z-bus Matrix (without mutual impedance).

Practice:

1. Calibration of Tong Tester.
2. Formation of Z-bus by building algorithm.

UNIT – IV

Fault analysis: Symmetrical fault analysis, Symmetrical components of unbalanced three phase systems, Sequence impedances and Sequence networks, Unsymmetrical Fault analysis.

Practice:

1. Estimation of Sequence impedances of 3phaseTransformer.
2. Estimation of sequence impedances of 3-phase Alternator by Fault Analysis.
3. Estimation of sequence impedances of 3-phase Alternator by Direct method.
4. Estimation of ABCD parameters on transmission line model.

UNIT – V

Power System Stability Analysis: Concepts of Steady state and transient stability, Swing equation, Equal area criterion, Introduction to Multi-Machine stability analysis.

Practice:

1. Power Angle Characteristics of 3-phase Alternator with infinite bus bars.

Additional practice:

1. Transient Stability analysis of single machine connected to an infinite bus (SMIB) using equal area criterion.
2. Estimation of fault currents for LG fault.
3. Estimation of fault currents for LL fault.
4. Develop a program for the solution of swing equation.

Capstone Project:

Develop a small program (e.g., in Python or MATLAB script) that takes power system component parameters (voltage, MVA, impedance in Ohms/percentage) and base values as input, then converts them to per unit values. Extend it to automatically calculate and display the per unit impedance diagram for a very simple power system (e.g., a generator, transformer, and load).

Text Books:

1. Electrical Power Systems - by C.L. Wadhwa: New Age International Pub. Co (ISBN: 9789393159175).
2. Modern Power system Analysis – by I. J. Nagrath & D. P. Kothari: Tata McGraw–Hill Publishing Company, 5th edition-2022 (ISBN: 978935460968)

Reference Books:

1. Elements of Power system Analysis -by W.D. Stevenson: McGraw Hill International Student (ISBN: 978070612822).
2. Power System Analysis -by Hadi Saadat: Tata Mc Graw Hill Pub.Co (ISBN: 9780984543861).

Web Links:

1. https://onlinecourses.nptel.ac.in/noc18_ee16/
2. http://nptel.ac.in/courses/108105067/3
3. https://nptel.ac.in/courses/108104051/

Switch Gear & Protection

	L	T	P	C
Course Code: 2501EE15	**3**	**0**	**0**	**3**

Course Outcomes:

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

- **CO1** Apply the Knowledge of arc interruption for application to high voltage circuit breakers of oil, Vacuum & SF6 gas type.
- **CO2** Explain the working principle & operation of different types of electromagnetic protective relays.
- **CO3** Analyze the various protective schemes for power generators & transformers.
- **CO4** Apply various types of protective schemes used for feeders & bus bar protection.
- **CO5** Explain over voltage protection schemes & methods of neutral grounding.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	1
CO3	2	1
CO4	2	
CO5	2	1

UNIT – I

Circuit Breakers: Elementary principles of arc interruption– Restriking Voltage & Recovery voltages– Restriking phenomenon - RRRV– Average & Max. RRRV– Current chopping & Resistance switching – Concept of oil circuit breakers – Vacuum & SF6 circuit breakers– Concept of Auto reclosing – Applications.

UNIT – II

Electromagnetic Protection: Balanced beam type attracted armature relay - induction disc & induction cup relays–Torque equation - Relays classification: –Instantaneous– DMT & IDMT types– Applications of relays: Over current & under voltage relays– Directional

relays– Differential relays & percentage differential relays–Universal torque equation– Distance relays: Impedance– Reactance– Mho & offset mho relays.

UNIT – III

Generator Protection: Protection of generators against stator faults– Rotor faults & abnormal conditions– restricted earth fault & inter turn fault protection.
Transformer Protection:
Percentage differential protection– Design of CT's ratio– Buchholz relay protection.

UNIT – IV

Feeder & Bus bar Protection: Over current Protection schemes – PSM – TMS – Carrier current & three zone distance relay using impedance relays - Protection of bus bars by using Differential protection.

UNIT – V

Protection against over voltage & grounding: Generation of over voltages in power systems– Protection against lightning over voltages – Valve type & zinc oxide lighting arresters.
Grounded & ungrounded neutral systems – Effects of ungrounded neutral on system performance – Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds & grounding Practices

Text Books:

1. Power System Protection & Switchgear by Badri Ram & D.N. Viswakarma - Tata McGraw Hill Publications – 3rd edition - 2023.
2. Power system protection- Static Relays with microprocessor applications by T. S. Madhava Rao - Tata McGraw Hill - 2nd edition.

Reference Books:

1. Fundamentals of Power System Protection by Y. G. Paithankar & S. R. Bhide – PHI.
2. Art & Science of Protective Relaying – by C R Mason - Wiley Eastern Ltd

Web Links:

1. https://nptel.ac.in/downloads/10811039/
2. http://electrical-engineering-portal.com/

Energy Converters

	L	T	P	C
Course Code: 2501EE39	**2**	**1**	**0**	**3**

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Classify the different types of converters.
CO2: Explain the resonant converters.
CO3: Illustrate the steady state analysis of power factor corrected converter.
CO4: Identify the various modulation techniques for single phase inverter.
CO5: Explain the operation of various Multilevel Inverters and it's comparison.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1						1	1	
CO2	2	3	2						1	1	
CO3	3	2	2						1	1	
CO4	2	3	2						1	1	
CO5	3	2	2						1	1	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	2	1
CO3	2	1
CO4	2	1
CO5	2	1

UNIT – I
Switching Voltage Regulators:
Isolated converters dc-dc converters: Forward converter, Half bridge, Full bridge configurations, Push-pull converter, Cuk converter, SEPIC Converter, Comparison of isolated and non-isolated converters, Design criteria for SMPS, Multi-output switch mode regulator.

UNIT – II
Resonant Converters: Classification, Load resonant converters, Resonant switch converters, Zero voltage switching dc-dc converters, Zero current switching dc-dc converters, Clamped voltage topologies.

UNIT – III

Voltage control of PWM Inverters: Single-phase inverters - Sinusoidal PWM, Modified PWM, Phase displacement Control, Trapezoidal, Staircase, Stepped, Harmonic injection and delta modulation.

Three-Phase Inverters: Sinusoidal PWM, Third Harmonic PWM, Space Vector Modulation, Comparison of PWM Techniques.

UNIT – IV

Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter.

UNIT – V

Multilevel Inverters: Types of Multilevel Inverters, Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter Switching Device Currents- Features of Multilevel Inverters Comparisons of Multilevel Converters.

Text Books:

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland (ISBN: 9780471226932).
2. Power Electronics-Md.H.Rashid –Pearson Education Third Edition (ISBN: 9788120345317).

Reference Books:

1. Control in power electronics by Marian P. Kaźmierkowski, Ramu Krishnan, Frede Blabjerg Edition Published by Academic Press (ISBN: 9780124027725).
2. High Power Converters and AC Drives, Bin Wu, John Willey & sons, Inc (ISBN: 9781119156031).

Web links:

1. **https://onlinecourses.nptel.ac.in/noc24_ee88/preview.**
2. **https://archive.nptel.ac.in/courses/108/102/108102157/.**

Power System Operation & Control

	L	T	P	C
Course Code:2501EE16	**2**	**0**	**2**	**4**

Course Outcomes:

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

- **CO1** Compute optimal load scheduling of Generators.
- **CO2** Formulate hydrothermal scheduling & unit commitment problem
- **CO3** Analyze effect of Load Frequency Control for single area systems
- **CO4** Analyze effect of Load Frequency Control for two area systems
- **CO5** Describe the effect of reactive power control for transmission lines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	1						1		
CO2	2	3	1						1		
CO3	2	3	1						1		
CO4	2	3	1						1		
CO5	2	3	1						1		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	
CO2	2	
CO3	1	
CO4	1	
CO5	1	

UNIT – I

Economic Operation of Power Systems : Optimal operation of Generators in Thermal power stations - – Heat rate curve – Cost Curve – Incremental fuel & Production costs – Input–output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss Coefficients – General transmission line loss formula.

Practice:

1. Economic load dispatch with losses.
2. Economic load dispatch without losses.

UNIT – II

Hydrothermal Scheduling-Mathematical Formulation – Solution Technique. Unit Commitment-Need for unit commitment – Constraints in unit commitment – Cost function formulation – Solution methods – Dynamic programming.

Practice:

1. Unit commitment problem by using dynamic programming approach.

UNIT – III

Load Frequency Control-I: Modelling of steam turbine – Generator – Mathematical modelling of speed governing system – Transfer function. Definitions of Control area, Single area control system – Block diagram representation of an isolated power system – Steady state analysis -Dynamic response. Proportional plus Integral control of single area & its block diagram representation – Steady state response.

Practice:

1. Load frequency control of a Single area Power System without PI controller.
2. Load frequency control of a Single area Power System with PI controller.

UNIT – IV

Load Frequency Control-II: Block diagram development of Load Frequency Control of two area system – Load Frequency Control & Economic dispatch control.

Practice:

2. Load frequency control of a two area Power System without PI controller.
3. Load frequency control of a two area Power System with PI controller.

UNIT – V

Compensation in Power Systems: Overview of Reactive Power control – Reactive Power compensation in transmission systems. Introduction of FACTS devices – Need of FACTS controllers – Types of FACTS devices.

Practice:

1. Performance of long transmission line without compensation.
2. Performance of long transmission line without compensation.
3. Design of Thyristor controlled Series Reactor.

Additional practice:

1. Design a Thyristor Switched Capacitor.
2. Design a Thyristor Controlled Series Compensator.
3. Optimum generation for a hydro-thermal scheduling with inflow & without losses

Capstone Project:

Develop a program (e.g., in MATLAB script or Python) that performs economic dispatch for a small thermal power system (e.g., 2-3 generators). The program should take heat rate/cost curves (or simplified quadratic cost functions) as input and determine the optimal power generation for each unit to meet a given load, neglecting transmission losses.

Text Books:

1 Power Generation - Operation & Control by Allen J Wood - Bruce F WollenBerg 3rd Edition - Wiley Publication (ISBN: 9780471586999).
2 Modern Power System Analysis – by I.J.Nagrath & D.P.Kothari Tata McGraw Hill Publishing Company Ltd – 5th edition-2022 (ISBN: 978935460968).

Reference Books:

1 Power System Analysis & Stability by S.S.Vadhera - Khanna Publications - 7th edition – 2024 (ISBN: 9788174090591).
2 Power System stability & control - Prabha Kundur - TMH – 2nd edition -2022 (ISBN: 978070635159).

Web Links:

1 https://nptel.ac.in/courses/108104052/
2 https://nptel.ac.in/downloads/10811040/
3 https://nptel.ac.in/courses/10811040/