

Semester VI

Curriculum and Credit Framework for Undergraduate Programme of Physics Hons. (single Major) w.e.f. 2024 (NEP 2020)

Course	Course Code	Name of the Paper	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				Th	Pr	T		
CC- 12	PHSUMC C612	Mathematical Physics-III and Modern Physics Practical	Practical	0	8	0	4	50 CIA=30 (Gr.A-15, Gr.B-15) ESE=20 (Expt=15, Viva=5)
CC- 13	PHSUMC C613	Electromagnetic Theory	Theory	4	0	0	4	50 (ESE=40, IA-7, CA-3)
CC-14	PHSUMC C614	Quantum Mechanics-I	Theory	4	8	0	4	50
CC-15	PHSUMC C615	Quantum Mechanics and Electromagnetic Practical	Practical	0	8	0	4	50 CIA=30 (Gr.A-15, Gr.B-15) ESE=20 (Expt=15, Viva=5)
DSE2	PHSUDSE 602	Nuclear and Particle Physics	Theory	4	0	0	4	50
GE2C (MIC)	PHSUMIC 603	Electricity, Magnetism and EM Theory	Theory	4	0	0	4	50

Th= Lecture, **T**= Tutorial, **Pr** = Practical, **CC** - Core Course, **DSE**=Discipline Specific Elective, **IA**= Internal Assessment, **CA**= Class attendance.

CIA=Continuous Internal assessment, **ESE**=End semester examination, **Expt.**=Experiment

CC 12: Mathematical Physics-III and Modern Physics Practical
(Credits:4)

Group-A
(Mathematical Physics-III)

**Python + Scientific Packages based simulations experiments based on
Mathematical Physics problems like the following:**

List of Computer Experiments

1. Solve differential equations:

$$\frac{dy}{dx} = e^{-x} \text{ with } y = 0 \text{ for } x = 0$$

$$\frac{dy}{dx} + e^{-x} = x^2$$

$$\frac{d^2y}{dt^2} + 2\frac{dy}{dt} = -y$$

$$\frac{d^2y}{dt^2} + e^{-t}\frac{dy}{dt} = -y$$

2. Dirac Delta Function:

Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-\frac{(x-2)^2}{2\sigma^2}} (x+3) dx$, for $\sigma = 1, 0.1, 0.01$ and show it tends to 5

3. Fourier Series:

Program to sum $\sum_{n=1}^{\infty} (.2)^n$ Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:

$$\int_{-1}^{+1} P_n(x) \cdot P_m(x) dx = \delta_{n,m}$$

Plot $P_n(x), j_\mu(x)$. Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.
7. Evaluation of trigonometric functions e.g. $\sin \theta$, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2 + 2)$ numerically and check with computer integration
8. Compute the nth roots of unity for $n = 2, 3$, and 4.
9. Find the two square roots of $-5+12j$.
10. Integral transform: FFT of $\exp(-x^2)$

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab (A free software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- https://web.stanford.edu/~boyd/ee102/laplace_ckts.pdf
- ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

Group-B (Modern Physics)

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine the Planck's constant using LEDs of at least 4 different colours.
4. To determine the wavelength of H-alpha emission line of Hydrogen atom.
5. To determine the ionization potential of mercury.
6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
8. To setup the Millikan oil drop apparatus and determine the charge of an electron..
9. To determine the wavelength of laser source using diffraction of single slit.
10. To determine the wavelength of laser source using diffraction of double slits.
11. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal

CC 13: ELECTROMAGNETIC THEORY (Credits: 04, Lectures 60)

This course enriches the students about the electromagnetic nature of light and the interaction of light with matter. Students will perform various experiments to determine the behavior of light in a medium. They also determine few fundamental constants in laboratory.

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector.

Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density. **(12 Lectures)**

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

Normal and Anomalous Dispersion. Cauchy and Sellmeier relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes. **(14 Lectures)**

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)

(10 Lectures)

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light. **(12 Lectures)**

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter. **(4 Lectures)**

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission. **(5 Lectures)**

Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). **(3 Lectures)**

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Engineering Electromagnetic, William H. Hayt, 8th Edition, 2012, McGraw Hill.
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Additional Books for Reference

- Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press

CC 14: QUANTUM MECHANICS -I

(Credits: 04, Lectures 60)

This course introduces the concepts of Quantum theory and calculations over simple physical systems. Special numerical methods are taught to solve simple quantum mechanical problems and visualize.

Hilbert Space and wavefunction: Linear vector space, Hilbert space, Dimension and basis of a vector space, Square integrable functions: Wavefunctions, Dirac notation, Properties of Kets, Bras and Brackets.

(2 Lectures)

Operators: Linear operators, Hermitian adjoint, Hermitian and Skew Hermitian operators, Projection operator, Identity operator, Commutator Algebra, Uncertainty relation between two operators, Functions of operators, Relations involving function operators, Unitary operator, Eigen values and eigen vectors of an operator, Some important theorem to the eigen value problem.

(5 Lectures)

Unitary Transformations: Properties of unitary transformation, Change of bases, Infinitesimal and finite unitary transformations.

(3 Lectures)

Representation in discrete bases: Matrix representation of Kets, bras and operators.

(2 Lectures)

Representation in continuous bases: Position representation, Momentum representation, connection between them, Momentum operator in position representation, position operator in momentum representation, Commutator relations.

(4 Lectures)

Closure relation in discrete and continuous bases, Hamiltonian eigen value equation in discrete and continuous bases, Matrix Mechanics and Wave Mechanics. Problems.

(4 Lectures)

Postulates of quantum Mechanics: State of a system, Probability density, observables and operators, Measurements in quantum mechanics, Expectation value, Complete set of commuting operators, Time evolution of the system's state, Time evolution operator, Time evolution of expectation values.

(6 Lectures)

Symmetries and conservation laws: Space and time displacement, rotation, conserved quantities.

(2 Lectures)

Connecting quantum to classical Mechanics: Poisson Brackets and commutators, Ehrenfest theorem.

(2 Lectures)

Harmonic Oscillator Problem: Raising and lowering operators, Energy eigen values and eigen states, zero point energy, eigen states in position representation, Matrix representation of various operators, Expectation values of various operators, Uncertainty relation, idea of coherent states, Extend the idea 1D to 3D, Degeneracy.

(5 Lectures)

General Formalism of Angular Momentum: Commutation relations, Eigen values and eigen states of the angular momentum operator, Matrix representation of angular momentum, Spin angular momentum, Spin-1/2 and the Pauli matrices, Commutator relation, Properties and eigen values and eigen vectors of Pauli spin matrices; Addition of angular momenta, CG coefficients.

(10 Lectures)

Quantum theory of hydrogen-like atoms: Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m ; s, p, d,...

shells. Parity of the wavefunction, Degeneracy of the bound states, Probabilities and averages.

(10 Lectures)

Pictures in quantum mechanics: Schrodinger, Heisenberg and interaction pictures, Matrix theory of harmonic oscillator.

(5 Lectures)

Reference Books:

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
 - Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
 - Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
 - Quantum Mechanics, G. Aruldas, 2nd Edn. 2002, PHI Learning of India.
 - Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
 - Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
 - Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press.
 - Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
 - Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
 - Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer
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CC15: Electromagnetic Theory and Quantum Mechanics

Practical

(Credit-4)

Group-A

(Electromagnetic Theory)

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.

8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan's law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing

House.

- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Group-B (Quantum Mechanics)

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2} [V(r) - E]$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is -13.6 eV. Take $e = 3.795$ (eVÅ)^{1/2}, $\hbar c = 1973$ (eVÅ) and $m = 0.511 \times 10^6$ eV/c².

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2} [V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential:

$$V(r) = -\frac{e^2}{r} e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take $e = 3.795$ (eVÅ)^{1/2}, $m = 0.511 \times 10^6$ eV/c², and $a = 3$ Å, 5 Å, 7 Å. In these units $\hbar c = 1973$ (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2} [V(r) - E], \text{ for the anharmonic oscillator}$$

potential, $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$ for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $m = 940$ MeV/c², $k = 100$ MeV fm⁻², $b = 0, 10, 30$ MeV fm⁻³. In these units, $\hbar c = 197.3$ MeV fm. The ground state energy is expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule.

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{\hbar^2} [V(r) - E], \text{ where } \mu \text{ is the reduced mass of the two-atom system of Morse potential:}$$

$$V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'}), r' = \frac{r-r_0}{r_0}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: $m = 940 \times 10^6$ eV/c², $D = 0.755501$ eV, $\alpha = 1.44$, $r_0 = 0.131349$ Å

Reference Books:

- Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al., 3rd Edn., 2007, Cambridge University Press.
- An introduction to computational Physics, T.Pang, 2nd Edn., 2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & co.

DSE2: Nuclear Physics and Particle Physics:

(Credits: 4, Lectures 60)

From this course students will learn about the nature of atomic nucleus, their interactions, and the nature of the basic constituents of matter and radiation. Students will learn and aware about nuclear energy and its applications.

General Properties of Nuclei:

Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excited states. **(Lectures 08)**

Nuclear Models:

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **(Lectures: 10)**

Radioactivity decay:

Alpha decay: basics of α -decay processes, theory of α - emission, Gamow factor, Geiger Nuttall law, α -decay spectroscopy. (b) β -decay: energy kinematics for β -decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **(Lectures: 08)**

Nuclear Reactions:

Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(Lectures: 6)**

Interaction of Nuclear Radiation with matter:

Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. **(Lectures: 8)**

Detector for Nuclear Radiations:

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. **(Lectures: 7)**

Particle Accelerators:

Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. **(Lectures: 5)**

Particle physics:

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. **(Lectures:8)**

Reference Books:

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
4. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
5. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
6. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
7. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
8. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
9. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
10. Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub.Inc., 1991).

GE2C (MIC) : Electricity, Magnetism and EM Theory (Credits: 4, Lectures 60)

This course offers fundamental concepts of electricity and magnetism. Students learn the ideas through problem solving and laboratory experiments. Applications involve electrical and magnetic properties of matter, electrical networks and devices.

THEORY

(Credits: 4, Lectures 60)

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

(25 Lectures)

Magnetism:

Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro- magnetic materials. **(10Lectures)**

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

(6 Lectures)

Maxwell's equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

(10 Lectures)

Electrical Circuits: AC Circuits: Kirchoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

(5 Lectures)

Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

(4 Lectures)

Reference Books:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
 - Electricity & Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press
 - Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
 - University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J.Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

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