DEPARTMENT OF PHYSICS

SAURASHTRA UNIVERSITY

RAJKOT

M.Sc. (Physics)
(effective from July 2002)

COURSE STRUCTURE, REGULATIONS & SYLLABI

SAURASHTRA UNIVERSITY
RAJKOT

Revised M.Sc. (Physics) Syllabus and Regulations in force from July, 2002 as per UGC guidelines.

Regulation 1
There will be 16 theory papers of which 11 are core papers, 1 elective and 4 specialization papers distributed into 4 semesters. In each semester, there will be 4 theory papers and one Practical course. Examination in each theory paper will be of 3 hours duration and will carry 100 marks and each practical and/or project examination of 3 hours duration and of 200 marks. This 200 marks will consist of 150 marks for the practical and/or project and 50 marks for Viva.

The instruction will be of 4 hours per week for each theory paper, 1 hour per week of tutorial for each theory paper. There will be 9 hours per week of Practical/project work and 2 hours per week of tutorial on Practical/Project work.

The structure is summarized in the table below:

Regulation 2
Grant of term (admission to examination will be based on satisfactory attendance as per University rules.

Regulation 3
Promotion to higher semester : Promotion to third semester (2^{nd} year will be give to only those who have cleared at least 5 theory papers out of 8 in 1^{st} and 2^{nd} semesters combined.

Regulation 4
Course is full time and is divided into 4 semesters (2 years). In each semester, not less than 13 weeks of actual teaching is necessary, after completing which only the examination should be conducted.

Regulation 5
Passing standards and award of class:
For passing, 40% marks in each theory and practical and/or project examination is compulsory. Students securing 50% and above but less than 60% in the aggregate will be awarded Second Class. 60% and above but less than 70% will be awarded First class. Students securing 70% and above in the aggregate will be awarded Distinction.

COURSE STRUCTURE
Semester-I

Paper No.	Title of the Paper	Hrs. of* Instruction	Hrs. of* Tutorial	Marks
I	Mathematical Physics	52	13	100
II	Classical Mechanics	52	13	100
III	Electronic Devices & Circuits	52	13	
IV	Quantum Mechanics	52	13	100
-	Practicals	117	26	200
-	Total for SEMESTER-I	325	78	600

Semester-II

V	Quantum Mechanics II & Statistical Mechanics	52	13	100
VI	Electrodynamics & Plasma Physics	52	13	100
VII	Atomic & Molecular Physics	52	13	100
VIII	Space Physics	52	13	100
-	Practicals	117	26	200
-	Total for SEMESTER-II	325	78	600

Semester-III

IX	Solid State Phyiscs	52	13	100
X	Nuclear & Particle Physics	52	13	100
XI	Special Paper I	52	13	100
XII	Special Paper II	52	13	100
-	Practicals	117	26	200
-	Total for SEMESTER-III	325	78	600

Semester-IV

XIII	Computational Methods & Programming	52	13	100
XIV	Elective Paper	52	13	100
XV	Special Paper III	52	13	100
XVI	Special Paper XVI	52	13	100
-	Practicals and Project	117	26	200
-	Total for SEMESTER-IV	325	78	600

-	GRAND TOTAL for Sem-I to IV	1300	312	2400

- **Assuming 13 weeks of teaching per Semester**

Summer Training/Educational Tour during vacations as a part of study for exposure to R & D Institutions and Industrieis.

Special Papers : (In Semester III & IV)

1. **Electronics**
2. **Materials Science (Condensed Matter Physics)**
3. **Space Physics**
4. **Subatomic Physics (Nuclear and Particle Physics)**

Electives : (In Semester IV)

1. **Experimental Techniques in Physics**
2. **Laser Physics and Applications**
3. **Physics of Nono Materials**
4. **Atmospheric Physics**
5. **Physics of Electronic Devices and IC Fabriaction Technology**
6. **Science & Technology of Solar and other renewable energy**
7. **Microprocessors**

DEPARTMENT OF PHYSICS
SAURASHTRA UNIVERSITY
RAJKOT
New distribution of marks for M.Sc. (Physics) course
(Effective from the Academic Year: 2008-09)

Semester-I

Paper No.	Title of the Paper	External Marks	Internal Marks	Total Marks
I	Mathematical Physics	70	30	100
II	Classical Mechanics	70	30	100
III	Electronic Devices & Circuits	70	30	100
IV	Quantum Mechanics-I	70	30	100
-	Practicals	200	NIL	200
-	Total for SEMESTER-I			600

Semester-II

V	Quantum Mechanics II & Statistical Mechanics	70	30	100
VI	Electrodynamics & Plasma Physics	70	30	100
VII	Atomic & Molecular Physics	70	30	100
VIII	Space Physics	70	30	100
-	Practicals	200	NIL	200
-	Total for SEMESTER-II			600

Semester-III

IX	Solid State Phyiscs	70	30	100
X	Nuclear & Particle Physics	70	30	100
XI	Special Paper I	70	30	100
XII	Special Paper II	70	30	100
-	Practicals	200	NIL	200
-	Total for SEMESTER-III			600

Semester-IV

XIII	Computational Methods & Programming	70	30	100
XIV	Elective Paper	70	30	100
XV	Special Paper III	70	30	100
XVI	Special Paper IV	70	30	100
-	Practicals and/or Project	200	NIL	200
-	Total for SEMESTER-IV			600

-	GRAND TOTAL for Sem-I to IV			2400

Specializations offered: (In Semester III & IV)
Each specialization will have FOUR special papers: I to IV

1. **Electronics**
2. **Materials Science (Condensed Matter Physics)**
3. **Space Physics**
4. **Subatomic Physics (Nuclear and Particle Physics)**

Elective Papers : (In Semester IV)

1. **Experimental Techniques in Physics**
2. **Laser Physics and Applications**
3. **Physics of Nono Materials**
4. **Atmospheric Physics**
5. **Physics of Electronic Devices and IC Fabriaction Technology**
6. **Science & Technology of Solar and other renewable energy**

Microprocessors

Amendment in Regulations:Effective from June 2008

Regulation 1

There will be 16 theory papers of which 11 are core papers, 1 elective and 4 specialization papers distributed into 4 semesters. In each semester, there will be 4 theory papers and one Practical course. **The external Examination in each theory paper will be of 3 hours duration and will carry 70 marks and each practical and/or project examination of 3 hours duration and of 200 marks.** This 200 marks will consist of 150 marks for the practical and/or project and 50 marks for Viva.
The instruction will be of 4 hours per week for each theory paper, 1 hour per week of tutorial for each theory paper. There will be 9 hours per week of Practical/project work and 2 hours per week of tutorial on Practical/Project work.

Regulation 5
Passing standards and award of class:
For passing, 40% marks in each theory and practical and/or project examination is compulsory. Students securing 50% and above but less than 60% in the aggregate will be awarded Second Class. 60% and above but less than 70% will be awarded First class. Students securing 70% and above in the aggregate will be awarded Distinction.

The Internal test in each paper will be of total 30 marks. There will be TWO internal tests per semester per paper. The overall passing standard in the internal test will be 40% i.e. 12 marks out of 30 marks per paper. If student remains absent in internal test, he/she will lose the marks and under no circumstances supplementary internal test will be conducted. If student fails to appear for both the internal tests then his/her term will not be granted.

M.Sc. (Physics Semester-I
Paper I : MATHEMATICAL PHYSICS

Ordinary differential equations, Introduction

Solution of second order differential with variable coefficients (1) Homogenous equations
(2) Inhomogeneous equations

Series integration method of the solution of linear differential equations (Frobenius' method)

Legendre differential equation, Bassel differential equation: generating functions, Recurrence relations & orthogonality for above two equations, Rodriguez formula of Legendre polynomials, Integral representation of Jn(x) values of Bessel function of half odd integers.

Hermite differential equations, Integral formula for Hermite polynomials, Recurrence formula for Hermite Polynomials, orthogonality of Hermite polynomials, Rodrigues formula.

Lagurrer's differential equations, integral formula for Lagurrer's polynomial, Recurrence formula for Lagurrer polynomial, Recurrence formula for Lagurrer's polynomials.

Integral transform, Laplace transform some simple properties of Laplace transforms(a) linearity property(b shifting properties, first & second shifting.

Laplace transform of derivatives and integral, Inverse Laplace transform by partial functions, The Fourier transform, Fourier sine & cosine transform simple application of Fourier transform.

Text Books:

Mathematical Physics by Rajput
Mathematics for Physicists by M.L. Boas
Mathematical Methods for Physics by G. Arfkan

M.Sc. (Physics Semester I
Paper-II Classical Mechanics

Momentum conservation Angular momentum conservation. Conservation of energy. The Virial theorem

The equation of motion and first integrals. The differential equation for the orbit. Conditions for closed orbits. Bertrand's theorem. Kepler's problem. Inverse square law of force. Classification of orbits. Rutherford scattering.
Canonical transformations. Gauge transformation. The equations of canonical transformation. Example of harmonic oscillator. Poisson brackets properties of Poisson brackets. The angular momentum Poisson bracket relation.
Hamilton-Jacobi theory. Hamilton-Jacobi equation for Hamilton's principal function. Harmonic oscillator example. Hamilton's characteristic and principal functions. Variation Principle Hamilton's principle.
Some techniques of the calculus of variations. Derivation of Lagrange's equations from Hamilton's principle.
Moving coordinate system. Coordinate system with relative translational motions. Rotating coordinate systems. The coriolis force. Motion on the earth and Foucault pendulum. Small oscillations, general case of coupled oscillations. Eigen vectors and eigen frequencies. Normal coordinates, Small oscillations of particles on string.

Text Books:

Classical Mechanics – H. Goldstein
Classical Mechanics – N.C. Rana and P.S. Joag

Reference Books:

Introduction to Classical Mechanics – R.G. Takwale & Puranik
Classical Mechanis of Particles and Rigid Bodies – Kiran C. Gupta
Classical Mechanics – Y.R. Waghmare
Classical Mechanics – Bhatia
Classical Mechanics – Leech

M.Sc. (Physics) Semester-I
Paper III : ELECTRONIC DEVICES & CIRCUITS

Brief review of semiconductor theory, P-N junction, equilibrium conditions, contact potential diode current equations under forward and reverse bias conditions, reverse saturation current, reverse bias break down, transition and idiffusion capacitance, reverse recovery time, diode as a switch, Zener effect, Zener diode.

Bipolar junction transistor, current flow mechanism, transistor amplifying action, common emitter configuration and Ebers-Moll equations, analysis of CE amplifier circuit, maximum symmetrical swing, arbitary Q-point placement, emitter bypass capacitor and AC coupled load, Emitter follower, Small signal and low frequency analysis of CE and CB amplifiers and Emitter Follower circuit using hybrid parameter equivalent circuits.

Junction Field Effect Transistor (JFET), basic operation, drain-source and transfer characteristics, JEET parameters, MOSFET biasing, JFET small signal model, common source amplifier circuits, source follower, small signal operation with source resistance and loading effects.

PNPN devices, Silicon controlled rectifier, basic operation and theory, anode current equation, regenerative effect. I-V Characteristic, triggering methods, applications, TRIAC and its modes of operations, DIAC, Unijunction Transistor, Programmable UJT. Thermistor and its applications.

Photonic devices, Radiative and no-radiative trasitions, Photodetectors, bulk type and junction type, Light dependent resistor (LDR), diode photo detectors, PIN photodiode, solar cells, fill factor, Light emitting diode and its operation, semiconductor Laser, population inversion at junction optical gain and thereshold current for lasing.

Microware devices, Tunnel diode, Transfer electron devices (Gunn diode) Avalanche and transit time devices, IMPATT diodes, parametric amplifiers.

Reference Books:

Electronic circuits, Donald Schilling & Charles Belove, McGraw Hill
Solid State electronics devices, BenG. Streetman PHI
Elementary Solid State Physics, M. Ali Omar, Addison Wesley
Electronic devices and circuit theory, Robert Boylestad & Louis Nahselsky, PHI
Solid State Devices and integrated circuits, W.D. Cooper Weisbecker, Reston Pub (USA)
Electronic communication systems, George Kennedy, TMH
Integrated Electronics, Millman & Halkias, McGraw Hill
Solid state Devices & applications, Frederick Driscoll & Robert Coughlin, Prantice Hall

M.Sc, (Physics) Semester-I
Paper IV : Quantum Mechanics-I

One-dimensional harmonic oscillator by Schrodinger equation-power series solution. Plotting of harmonic oscillator wave functions-classical correspondence-operator methods.
Angular momentum commutation relation, Coordinate transformation, Angular momentum operators and its Eigen value problems in position representation, spherical harmonics. Solution of Schrodinger equation in three dimension separable variable method. Applications to (1) Square well (II) Attractive coulomb potential (III) Hydrogen atom. Dirac delta function. Bra and Ket notations. Matrix representation of an operator. The Unitary transformation.
Time independent perturbation theory. Stationary perturbation. Degenerate and no degenerate case. Application such as stark effect.
Time dependent perturbation. General formulation and the first order theory. Periodic perturbation and Fermi Golden Rule. Interaction of electromangnetic field with atom. Variational method. WKB approximation – Solution of one-dimensional Schrodinger equation.

Text Books:

Quantum Mechanics – Schiff (McGraw Hill)
A text book of Quantum Mechanics - Mathews and Venkatesan
Qauntum Mechanics – Amit Gowsami

Reference Books:

Fundamental of Quantum Mechanics – Vaghmare
Modern Quantum Mechanics – J.J. Sakurai
Quantum Mechanics – J.P.E. Peebles
Quantum Mechanics – K.K. Chopra, G.C. Agarwal

M.Sc. (Physics)
Practicals : Semester – I

(Any 12 to be performed)

1. V.I characteristics, max power dissipation of the Germanium diode.
2. V.I characteristics, breakdown voltage, dynamic resistance of the Zener diodes.
3. R-C time constant
4. Unregulated power supply
5. Regulated power supply
6. Zener diode voltage regulator (designing
7. Designing common-emitter amplifier
8. Network thermo : Thevenin's Norton's, Superposition
9. Study of bias stability
10. V-I characteristics of the UJT
11. Transistor (BJT) Characteristics and determination of h-parameters
12. JFET current – voltage characteristics
13. JFET transfer characterizes
14. MOSFET characteristics
15. Characteristics & application of LDR and photodiode.
16. Characteristics & applications of the SCR
17. BJT in CE configuration : Characteristics
18. BJT in CB configuration : Characteristics
19. Maximum power transfer theorem
20. Testing goodness of fit of Poisson distribution to cosmic rayt bursts by chi-square fit.
21. Counting Statistics
22. Determination of e/m of electron by normal Zeeman effect using Febry Perot Etalon.
23. Measurements of wavelength of He-Ne laser light using ruler.
24. Measurements of the thickness of write with laser.
25. Determination of half-life of In.
26. C.M. tube characteristics

M.Sc. (Physics) Semester – II
Paper-V (Statistical Mechanics and Quantum Mechanics-II

(1) Classical Statistical Mechanics
The postulate of classical statistical mechanics. Derivation of thermodynamics. Classical ideal gas. Gibbs Paradox. Equipartition uville theorem.

(2) Canonical Ensemble and Grand Canonical Ensemble:
Canonical ensemble. Energy fluctuations in canonical ensemble. Grand canonical ensemble. Density fluctuations in grand canonical ensemble.

(3) Quantum Statistical Mechanics
Postulate of Quantum Statistical mechanics. Density matrix. Macro-canonical ensemble, Canonical ensemble. The ideal gases. Micro-canonical ensemble.

(4) Superfluids:
Liquid helium. Why helium does not solidify ? Tisza's two-fluid model. The Bose-Einstein condensate Landau's theory.

(5) The Ising Model:
Definition of the Ising model. Lattice gas. Binary alloys.

(6) Scattering theory:
Kinematics of the scattering process. Differential and total cross-sections. Wave mechanical picture of scattering. The scattering amplitude. Green's functions. Formal expression for the scattering amplitude. Born approximation. The screened Coulomb potential. Validity of Born approximation. Born series. The Eikonel approximation.

(7) Partial Wave Analysis:
Definition of partial waves. Asymptotic behavior of partial waves :phase shifts (a) partial waves (b asymptotic form of radial function (c) phase shifts. The scattering amplitude in terms of phase shifts. The differential and total cross-sections. Optical theorem. Phase shifts : Relation to the potential. Expression for the phase shift.

Text Books:

(1) Statistical Mechanics – K. Huang (Wiley)
(2) Quantum Mechanics – Mathews and Venkatesan

Reference Books:

(1) Statistical Mechanics – F. Reif
(2) Statistical Mechanics – R.K. Pathria
(3) Statistical Mechanics – R. Kubo
(4) Statistical Physics – Landau and Lifshitz
(5) Quantum Mechanics – Schiff
(6) Quantum Mechanics – Peeble (PHI)
(7) Quantum Mechanics – Aruldhas (PHI)
(8) Quantum Mechanics – Y.R. Waghmare
(9) Quantum Mechanics – S.N. Biswas
(10) Quantum Mechanics – Thankappan
(11) Quantum Mechanics – Chopra and Agrawal (Krishna)

M.Sc. (Physics) Semester-II
Paper VI : Electrodynamics and Plasma Physics

Section A : Electrodynamics

Maxwell's equations:
Electrodynamics before Maxwell, Ampere's law, Maxwell's equation in matter and boundary condition.
Electromagnetic Waves
The wave equation for E and B propagation in linear media, Reflection and transmission at normal and oblique incidence, c.m. Waves in conductors.

Potentials and fields:
Scalar and vector potentials, gauge transformations, Coulomb Gauge Lorentz Guage. Retarded potentials, Lienard Wiechert potentials, the field of a moving point charge. Power radiated point charge.

Books:
Introduction to electrodynamics : D.J. Griffith
Electrodynamics : J.D. Jackson

Section B : Plasma Physics

Introduction to Plasma:
Definition of Plasma, Plasma parameters, Criteria for Plasma, Applications of Plasma.

Hydro dynamical description of Plasma:
Fluid equation of Plasma, Convective derivative, Fluid drifts perpendicular to B Plasma instabilities.

Waves in Plasma:
Phase velocity, group velocity, plasma oscillation, Resonance for EM waves propagating parallel and perpendicular to the magnetic field, Experimental consequences Whistler & Faraday Rotation, Hydro magnetic waves – Magneto sonic and Alfven waves.

Books:

Plasma Physics : Chen
Plasma Physics : Bitten court

M.Sc. (Physics) Semester-II
Paper VII : ATOMIC & MOLECULAR PHYSICS

Section I : Atomic Physics

Application of schrodinger equation for hydrogen atom, interpretation of the results of Schrodinger equation, atomic energy levels, dependence of wave function on the angle 0 and 0 radial dependence of wave function.

Pauli exclusion principle, maximum number of electrons in a given group or subgroup, different series in alkali spectra, term values in alkali spectra and quantum defect, spin-orbit interaction, doublet structure in alkali spectra coupling schemes. L-S coupling, JJ coupling interaction energy in L-S coupling & JJ coupling, fine structure & hyperfine structure (qualitative) Line-broadening mechanisms (general ideas, normal and anomalous Zeeman effect, Paschen-Back effect and Stark effect.,

Section-II : Molecular Physics

Rotation of molecules, classification of molecules, interaction of radiation with rotating molecule, rotational spectra of rigid diatomic molecules. Isotope effect in rotational spectra, intensity of rotation lines, non-rigid rotator, linear polyatomic molecules, symmetric top molecules, asymmetric top molecules, Stark effect, microwave spectrometer, information derived from rotational spectra.

Vibrational energy of a diatomic molecule, infrared spectra (preliminaries) Morse curve and the energy levels of a diatomic molecules. Vibrating diatomic molecule, diatomic vibrating rotator, vibration of polyatomic molecules, normal model of vibration in crystal, interpretation of vibrational spectra, I-R spectrophotometer-instrumentation.

Text Books:

Elements of Spectroscopy by Gupta Kumar Sharma
Molecular Str5ucture & Spectroscopy by G. Aruldhas
Introduction to Atomic Spectra by H.E. White
Introduction to Molecular Spectroscopy by G.M. Barrow

M.Sc. (Physics), Semester-II
Paper-VIII Space Physics (Core Paper)

Section A:

Basic concepts of earth's atmosphere:
Atmosphere nomenclature, Hydrostatic equations scale height, Geopotential height, Chemical concepts of atmosphere, Thermodynamic considerations, elementary chemical kinetics composition and chemistry of middle atmosphere and thermosphere. Thermal balance in the atmosphere, models of neutral atmosphere (CIRA, US Standard atmosphere, Sasi Model)

Dynamics of earth's atmosphere:
Equation of motion of neutral atmosphere, Thermal wind equation, elementary ideas of planetary waves, internal gravity waves and atmospheric tides.

Solar radiation and its effects on the atmosphere:
Solar radiation at the top of the atmosphere, Attenuation of solar radiation in the atmosphere, radiative transfer, thermal effect of radiation, photochemical effects of radiation, Airglow.

Structure and variability of Earth's ionosphere:
Introduction to ionosphere, photochemical processes, Chapman's theory of photoionization, production of ionospheric layers, loss mechanisms and chemistry of ionospheric regions, morphology of the ionosphere.

Section B:

Ionosphere propagation and measurement techniques:
Effect of Ionosphere on radiowave propagation, Refraction, Dispersion and polarization, Magnetoionic theory, critical frequency and virtual height, Oblique propagation and maximum usable frequency, Ground based techniques : ionosondes, radars, scintillation and TEC, ionospheric absorption, rocket and satellite borne techniques: Langmuir probe, electric field probe mass spectrometer.

Elements of solar physics:
Structure and composition of the Sun, sun as a source of radiation, sunspots an solar cycles, solar flares, coronal mass ejection, Techniques for monitoring the sun.

Magnetosphere of Earth:
Solar wind and its characteristics, Interplanetary magnetic field and sector structure, Formation of geomagnetic cavity, magnetopause, magnetosheath and bow shock, polar cusp and magnetotail, Plasmasphere and Van Allen radiation belts.

Concepts and foundations of Remote sensing:
Energy sources and Radiation principles, Energy interactions in the atmosphere, energy interactions with earth surface features, Data acquisition and Interpretations, Reference data, The Global Positioning System An ideal remote sensing system, Characteristics of real remote sensing system, Practical applications of remote sensing, Land and Geographic Information System.

Books:

Introduction to Ionosphere and Magnetosphere: J.A. Ratcliff (CUP)
The Solar-Terrestrial Environment: JK. Hargreaves (CUP)
Introdution Space Physics: M.J. Kievelson (CUP)
Chemistry Sensing and Image Interpretation: T.M. Lillesand and R.L. Kiefer, (John Wiley & Sons, 4^{th} Edition).

M.Sc. (Physics)
Practicals : Semester-II

(Any 12 to be performed)

1. Study of ionogram and diurnal variation of Ionospheric parameters
2. Measurement and analysis of earth's magnetic field using Proton Precession
3. Magnetometer
4. Bang gap energy of Selenium photoconduction cell
5. Production of plasma and measurement of its characteristics
6. Absorption spectra of iodine molecule
7. Hartman's formula
8. Study of FET as a source follower
9. Study of i/p and o/p characteristics of transistor for a CB Configuration
10. Study of I-V characteristics of a solar cell and find short circuit current, opn
11. circuit voltage fill factor and efficiency.
12. Verification of Truth table for AND and OR gate using diodes.
13. Study of I-V characteristics of Diac
14. Study of I-V characteristics of Red, Green, Yellow and Blue LEDs and
15. determination of knee voltage.
16. Study of I-V characteristics of TRIAC
17. Study of transistor as a CE amplifier and draw frequency response curve
18. Determination of Band gap Energy of given thermistor
19. Verification of maximum power transfer theorem using II and T network
20. Absorption coefficient of beta particles using A1-foils
21. Class-B push pull power amplifier
22. Effect of feedback on amplifier parameters.
23. Oscillator circuit using transistors.

M.Sc. (Physics) Semester-III
Paper IX : Solid State Physics

Crystal Physics and Defects in Solids:

Crystalline Solids, Unit cells and direct lattice, two and three-dimensional Bravais lattices, Closed packed structures.
Interaction of X-ray with matter, Absorption of X-rays, Reciprocal lattice and its applications, X-ray diffraction techniques, structure factor and intensity of X-ray diffraction.

Point defects, Line defects and stracking faults, Observation of imperfections and crystal growth, X-ray and electron-microscopic techniques.

Electronic Properties of Solids:

Electrons in periodic lattice, Bloch theorem, Band theory, Classification of Solids, Effective mass, Tight binding, Cellular and pseudo-potential methods, Fermi surfaces, De Hass Von Alfen effect, Cyclotron resonance, magnetoresistance, Superconductivity-critical temperature, persistent currents and Meissner effect.

Diamagnetism and Paramagnetism, Classical and Quantum, Ferri and Antiferri magnetic order, Domains and Bloch wall energy.

Text and Reference Books:

Solid State Physics C. Kittle (PHI)
Elementary Solid state physics, Ali Omar
Introduction to solids, Azaroff
Solid State Physics, Aschroft and Mermin
Crystallographyfor Solid State Physics, Varma & Srivastava

M.Sc. (Physics) Semester-III
Paper X (Nuclear and Particle Physics)

Basic Nuclear Concepts:
Basic nuclear properties – Nuclear mass, charge and size – Intrinsic angular momentum of a nucleus – Dynamic properties of nuclei – nomenclature

Nuclear Models:
Nuclear binding energy – semi empirical mass formula – mass parabola – liquid drop model of fission – experimental evidences for shell effects – shell model – spin orbit coupling – magic numbers – angular momenta and parities of nuclear ground states.

Nuclear Decay:
Beta decay – Fermi's theory of beta decay – shape of beta spectrum – comparative half lives – Allowed and forbidden transitions – selection rules – parity violation – detection and properties of neutrino – Gamma decay – energetics of gamma decay – angular momentum and selection rules – classification of gamma decays – Internal conversion.

Nuclear Interactions And Nuclear Reactions:
Nucleon – nucleon interaction – Meson theory of nuclear forces.
Types of nuclear reactions – Conservation laws – non-relativistic Q-equation – cross sections.

Elementary Particle Physics:
Types of interaction between elementary particles – hadrons and leptons – summetry and conservation laws – Elementary ideas of CP and CPT invariance – classification of hadrons – Quarks model – charm, bottom and top quarks.

Text and Reference Books:

L.E. Mayerhof, Elements of Nuclear Physics, Tata Mc Graw Hill, 1959.
Arthur Beiser, Concepts of modern physics, Mc Graw Hill Inter. 1987.
A.Bohr and B.R. Mottelson, Nuclear structure Vol.1 (1969) & Vol.2, Benjamin, Reading A., (1975)
Kenneth S. Kiane, Introductory Nuclear Physics, Wiley, New York, 1988.
Ghoshal, Atomic and Nuclear Physics, Vol.2
P.H. Perkins, Introduction to High Energy Physics, Addison-Wesley, London, 1982.
Shirokov Yudin, Nuclear Physics Vol. 1 & 2, Mir Publishers, Moscow, 1982
D. Griffiths, Introduction to Elementary Particles, Har4per and Row, New York, 1987.
H.A. Enge, Introduction to Nuclear Physics, Addision-Wesley, 1975
G.E. Brown and A.D. Jackson, Nucleon – Nucleon Interaction, North – Holland, Amsterdam 1976.

S. de Benedetti, Nuclear Interactio, Hohn Wiley &Sons, New York, 1964
M.K. Pal, Theory of Nuclear Structure, Affiliated East West Madras, 1982.
Y.R. Waghmare, Introductory Nuclear Physics, Oxford – IBH, Bombay, 1981
J.M. Longo, Elementary Particles, Mc Graw Hill, New York, 1971.
R.D. Evans, Atomic Nucleus, Mc Graw Hill, New York, 1955.
I. Kaplan, Nuclear Physics, 2nd Ed., Narosa, Madras, 1989.
B.L.Cohen, Concepts of Nuclear Physics, TMGH, Bombay, 1971
R.R.Roy and B.P. Nigam, Nuclear Physics, Wiley-Eastern Ltd. 1983.

M.Sc. (Physics), Semester-III, Special Paper
Paper-XI Space Physics

Ionospheric Plasma Dynamics:
Basic Fluid equations, steady state ionospheric Plasma motions due to applied forces, generation of Electric field mapping, collision frequencies, Electrical conductivities, Plasma diffusion, Ionospheric dynamo, Sq current system, Equatorial Electrojet & EIA.

Airglow and its measurement:
Night glow, Dayglow, Twilight glow, Aurora, Photometers, Spectrometers and imagers for airglow measureent, applications of Airglow measurement for ionospheric dynamics and composition.

Ionospheric Plasma irregularities:
E-region irregularities associated with electrojet, Sporadic-E, Auroral electrojet and associated irregularities, F-region irregularities, Equatorial Spread F and its various manifestations. Airglow depletions and plasma bubbles, Ground based, rocket borne and satellite based measurement techniques for these irregularities. Theories of ESF.

Ionospheric modeling and models:
IRI, SUPIM, TIGCM, PIM. Brief introduction to ionospheres of Mars, Venus and Jupiter.

M.Sc. (Physics), Semester-III, Special Paper
Paper XI : Material Science (Condensed Matter Physics)

Superconductivity:

Experimental results – d.c. electrical resistivity. Isotope effect, Meisner Effect, Type I & Type II superconductors. Theoritical approach. Thermodynamics of Superconducotr, London Equation, Brief explanation of BCS Theory, Flux Quantization Josephson tunneling, Ceramic superconductors, Application of superconducitivity.

Magnetic Properties:

Classification of magnetic materials. Dia and Para magnetism. Ferro and ferri magnetism. Ferri magnetism and two-sub lattice model. Ferri magnetic materials. Hard and Soft magnetic materials, Ferrites for microwave applications. Magnetic Bubbles.

Dielectric Properties:

Dielectric constant and polarizability, Electronic poloarizability, Ionic polarizability. Dielectric loss Insulating materials. Ferroelectrics, Piezoelectrics, Applications of Dielectric Materials.

Text Books:

Science of Engineering Materials, C.M. Srivastava and C. Srinivasan, Wiley-Eastern

Reference Books:

Elementary Siolid State Physics, Ali Omar, Solid State Physics, C. Kittel (PHI).

M.Sc. (Physics) Semester III, Special Paper
Paper XI : Subatomic Physics (Nuclear and Particle Physics)-1

Nuclear Radiation Detectors:

Ionizing radiations ; Ionization and transport phenomena in gas – Avalanche multiplication.

Detector Properties : Detection – Energy measurement – Position measurement Time measurement.

Gas Counters : Ionization chambers – Proportional counters – Multiwire proportional counters – Geiger – Muller counters – Neutron detectors.

Solid State Detectors : Semiconductor detector – Surface barrier detectors. Scintillation counters : Organic and inorganic scintillation – Theory, characteristics and detection efficiency.

High Energy Particle Detectors : General principles – Nuclear emulsions – Cloud chambers – Bubble chambers – Cerenkov counter.

Accelerators:

Historical Developments : Different types of accelerators –Layout and compoents of accelerators – Accelerator applications.

Transverse Motion : Hamiltonian for Particle motion in accelerators – Equation of betatron motion – particle motion in dipole and quadrupole magnets – Linear betatron motion – Longitudinal equation of motion.

Linear Accelerators : Historical milstones. Fundamental properties of accelerating structures Particle acceleration by EM waves – Longitudinal particle dynamics in Linac Transverse beam dynamic in a Linac.

Principle and Design Details of Accelerators : Basic principle and design details of accelerator viz electrostatic, electrodynamic resonant with special emphasis on microtron, pelletron and cyclotron – Synchrotron radiation sources – Spectrum of the emitted radiation and the applications.

Text and Reference Books:

S.S. Kapoor and V.S. Ramamurthy, Nuclear Radiation Detectors
Wiley – Eastern, New Delhi 1986.
W.H. Tait, Radiation Detection, Butterworths, London, 1980.
W.J. Price, Nuclear Radiation Detection, Mc Graw Hill, New York, 1964.
S.Y. Lee, Accelerator Physics, World Scientific, Singapore, 1999.
J.J. Livingood, Principles of Cyclic Particle Accelerators, D. Van Nostrand Co. 1961
J.P. Blewett, Particle Accelerators, McGraw Hill Book Co.
S.P. Kapitza and V.N. Melekhin, The Microtron, Harwood Academic Publishers
W. Scharf, Particle Accelerators and Their Uses, Harwood Academic Publishers
I.M. Kapchinskyu, Theory of Resonance Linear Accelerators, Harwood Academic Publishers
P. Lapostole and A. Septier, Linear Acccelerators, North Holland.

M.Sc. (Physics) Semester III, Special Paper
Paper XI : Electronics-1

Solid State Pulse Circuits:
Pulse nomenclature, risetime, fall time, duty cycle concept, tilt, waveform distortion and frequency response.

Capacitive resistance circuits:
R-C circuit response to square waves, integrating and differentiating circuits.
Clipping and clamping circuits using diodes.

Transistor as a switch : Switching time, improving switching time.

Schmitt trigger : Circuit operation, designing for a given upper trigger point (UTP) and lower trigger point (LTP), speed-up capacitor, input and out put characteristics.

Ramp generators : RC ramp generators, constant current ramp generators

Multivibrators
Collector coupled Astable multivibrator and monostable multivibrators, speed-up capacitors, triggering Collector-coupled bistable multivibrator, set-reset triggering.
The timer IC-555, functional block diagram, Astable & Monostable multivibrator using IC-555.

Microwave tubes:
Fundamentals of microwave technology, limitations of vacuum tubes.

Klystrons, Two cavity Klystron, Multi-cavity and Reflex Klystrons, Travelling wave tube, Magnetron.

Solid-State microwave devices : microwave transistors, diode, Tunnel diodes, Gunn Effect diodes, IMPATT diodes.

Books :

Solid State Pulse Circuits, David A Bell (PHI)
Electronic Communication Systems : George Kennedy TMH
Microwave Devices & Circuits, III Edition, Samuel Y. Liao, PHI

M.Sc. (Physics), Semester-III, Special Paper
Paper-XII Space Physics

Magnetic field of earth:
Models of generation of Geomagnetic field, Secular variations of geomagnetic field, International Geomagnetic Reference Field, Local elements of geomagnetic field Determination of geomagnetic coordinates of station, Geomagnetic field measurements variometers, proton precession magnetmeters, fluxgate magnetometers. Diurnal variation of geomagnetic field and its causes, magnetometry for seismic and other geophysical monitoring.

Space weather:
Geomagnetic storms, sub storms, magnetospheric formation, magnnetospheric current systems, coronal mass ejections, modification of magnetosphere during magnetic disturbances. Interplanetary magnetic field and its role in magnetic storms, magnetospheric whistlers and magnetic micropulsations, Interplanetary medium signatures of magnetic storms and solar transients, Effect of magnetic disturbances on space technology systems and at high, mid and low latitudes.

Measurement Techniques for Solar & Geomagnetic parameters:
Optical telescopes Radioheliographs and X-ray techniques for solar parameters, Techniques for solar magnetic measurements. Radio telescopes & IPS technique. Spacecraft measurements.

Introduction to Astrophysics:
Basic parameters of Astronomical measurements (magnitude scale, coordinate systems), Stellar classification, H.R. Diagram, Saha's equation, Jean's criteria for stellar formation, stellar evolution, Galaxy classification, Cosmology.

M.Sc. (Physics) Semester-III
Paper XII : Material Science (Condensed Matter Physics)

Crystal Physics and X-ray crystallography:

Symmetry of crystals-Symmetry elements – Classification of crystals. Periodicity in crystals. Lattice types – Transformation theory.

Space groups, Space-group symmetry. Derivative symmetry. Equivalent position in a unit cell.

Powder method. Theoretical considerations. Reciprocal lattice construction.
Measurement of d values. Sources of errors. Experimental procedures.
Indexing procedures. When crystal is known Inter-planar spacing relations. Graphical indexing. Analytical procedures. When the crystal is unknown. Tests for Cubic, tetragonal and hexagonal systems. Tests for orthohomibic system. General procddure-Ito's method Choice of correct cell. Qualitative analysis – Identification procedures. Powder diffraction file. Identification of mixture. Crystal size analysis. Effect on powder diffraction.

Residual Stress Analysis:

Structure factor determination. Determination of space group. Interactive methods, Fourier methods. Patterson functions.

Liquid crystals, Isotropic nematic and cholestric phases. Smectics-A-and-C-Hexatic phases. Lyotropic liquid crystals and microemulsions. Introduction of Qusicrystals, Fullerence nano-particles.

Text Books:

Elements of X-ray Crystallography, L.V. Azaroff, Mc Graw Hill.
Principles of Condensed Matter Physics, P.M. Chaikin & T.C. Lubensky
Cambridge University Press.

M.Sc. (Physics) Semester-III, Special Paper
Paper-XII : Subatomic Physics (Nuclear and Particle Physics)-2

Nuclear Reactions, Nuclear Energy and Nuclear Models:

Nuclear Reactions and Nuclear Energy

Nuclear reaction characteristics – Reaction energetics Non-relativistic and relativistic Q-equation – Energy correlation analysis – Energy levels in nuclei – Theories of nuclear reactions – Compound nucleus model – Breit – Wigner formula – Resonance scattering and resonance cross sections.

Nuclear Energy : The fission process – neutrons released in the fission process – Cross sections – The fission reactors – Fusion – Thermonuclear reactions – Energy production in stars.

Nuclear Models:

Nuclear shell model – Single particle potential – spin orbit potential – analysis of shell model predictions – signle aparticle shell model – total spins J for various configurations (J) – Nuclear isomerism – magnetic moment – configuration mixing – Individual (independent) particle model – Russell Saunders coupling (L-S) coupling – jj couplinhg scheme – transformation between the L-S and the jj coupling schemes and beta decay.

Unified (collective) model : Introduction – The vibrational modes of a spherical nucleus – Collective modes of deformed even-even nucleus – Symmetries of the collective wave function for well deformed eve-even nuclei – Collective spectraq of even-even nuclei.

Text and Reference Books:

M.A. Preston and R.K. Bhaduri, Structure of the Nucleus, Addison Wesley.
r.R. Roy and B.P. Nigam, Nuclear Physics : Theory and Experiments, Wiley Eastern.
P. Marmier and E. Sheldon, Physics of Nuclei and Particles, Vol.1, Academic Press.
M.A. Preston, Physics of the Nucleus, Addision Wesley.
W.S.C. Williams, Nuclear and Particle Physics, Clarendon Press.

M.Sc. (Physics) Semester-III, Special Paper
Paper-XII : Electronics-2

Microwave transmission lines:
Transmission line equations, solution of transmission line equation,Reflection coefficient, transmission coeffcient, standing waves and standing wave ratio, line impedance, impedance in terms of reflection coefficient, determination of characteristic impedance, normalized impedance, line admittance, Smith chart, impedance matching, single stub and double stub matching.

Wave guides:
Rectangular wave guides, solution of wave equation in rectangular coordinates. TE modes in rectangular wave guide, TM modes in rectangular wave guides, excitations of modes in rectangular wave guides. Rectangular-cavitiy resonator, directional couplers.

Antennas:
Terms and definition, Antenna gain, resistance, beamwidth and polarization, resonant & non resonant antenna, effect of ground on antennas, antenna height, directional high frequency antennas, dipole arrays, yagi-Uda antenna, parabolic reflector.

Radar System:
Basic princple, Radar performance factor, Radar Range equation, Factor influencing maximum range, pulsed radar system, antenna and scanning display methods, Moving target indication.

Books:
Microwave devices and circuits, III edition, Samual Y. Liao, PHI.
Electronic Communication Systems, George Kennedy, TMH.
Transmission lines ans networks, Umesh Sinha, Satya Prakashan, New Delhi.
Electronic Communication : Modulation & Transmission Robert J. Schoenback PHI.

M.Sc. (Physics) Semester-IV
Paper XIII : Computational Methods and Programming

Section-A

Methods of solving of linear and non-linear algebric equations, transcendental equations, Convergence of Solutions, Solution of simultaneous linear equations, Gaussian elimination.

Finite differences, interpolation with equally spaced and unevenly spaced points, Curve fitting, Polynomial, Least squares and Cubic Spline fitting.

Numerical differentian and integration, error estimates. Numerical solutions of ordinary differential equations – Euler and Runse-Katta methods.

Harmonic Analysis and FFT techniques.

Section-B

Elementary information about digital computers, Introduction to compilers and Operating systems, FORTRANS/VB programming introduction, Flow charges, Expressions, built in functions, control and input output elements, subroutines and functions, operation with files. Harmonic analysis and FFT using standard package.

Text Books:

Numerical Recipes – (CUP)
Numerical Analysis – Rajaraman
Programming & Computing with FORTRAN 77/9 – P.S. Grover
Beginning's guide & Visual Basic 6.0 – Sahoo (Khanna Bonc. Pub.)
Computer based Numerical Analysis – Shanthe Kumar (Khanna Pub.

M.Sc. (Physics) Semester-IV, Elective Paper
Paper : Atmospheric Physics

Radiative transfer in the atmosphere:
Temperature of the sun and spectral distribution of solar radiation, blackbody radiation budget of radiation energy, Passage of solar radiation through the atmosphere, atmospheric windows, emissivity, absorption spectra of atmospheric gases, optically thick and thin approximation, aerosol, scattering, calculation of radiative heating and coling, terrestrial radiation and its passage through the atmosphere.

Atmospheric thermodynamics:
Laws of thermodynamics, Lapse rate, thermodynamic equations entropy change water-air mixture, moisture variables, potential temperature, virtual temperature, thermodynamic diagram, dry and moist static energy, static stability, convective instability.

Cloud microphysics:
Cloud forms and characteristics, formation and growth of precipitation particles, terminal velocity, thunderstorms, artificial rain making.

Basic equations of atmospheric dynamics:
Equations of motion in spherical coordinates, rotating frame, coriolis force, quasistatic approximation, scale analysis, Rossby number, balanced flow, natural coordinate system, equations of continuity in spherical and Cartesian coordinates. Thermodynamic energy equations, pressure as vertical coordinate.

Atmospheric Circulation:
Circulation, Vorticity, divergence and deformation
Circulation theorems and applications, Barotropic and baroclinic fluids, dynamic instabilities.

Text Books:

Physical meteorology, H.G. Houghton, 1985
Atmospheric Sciences : an introductory survey, J.M. Vallace and P.V. Hobbs, Acad. Press, 1977.
A short course on cloud Physics, R.R. Rogers, 1979.
An introduction to dynamic meteology, J.R. Holton, Acad. Press, 1979.
Introduction to Theoretical Meteorology, S.L. Hess, 1959.
Atmospheric Waves, T. Beer, Wiley, 1974.
Atmospheric Tides, Chapman and Lindzen, Riedel, 1969.

M.Sc. (Physics) Semester-IV, Elective Paper
Paper XIV : Microprocessors

Basic Concepts : Evolution of microprocessors, organization of uP, Functional block diagram of uP, uP programming, digital logic, timing diagram conventions, data representation.

Programming a microprocessor : Organization of the 8085, Instruction set of the 8085, Assemkbler programming, Language for writing Algorithms, Programming examples.

Semiconductor memories : Static RAMs, Dynamic RAMs,Reprogrammable ROMs, memory system reliability.

Microprocessor timings : Timing and control unit, timing of Intel 8085, Register organization.

Interfacing memory & I/O devices : Address space partitioning, memory interfacing, data transfer schemes, programmed data transfer, direct memory access data transfer (DMA), serial data transfer.

Applications of microprocessor.

Books:

Introduction to microprocessor : Aditya P. Mathur, TMH
Introduction to microprocessors for Engineers and Scientists : P.K. Ghosh, and P.R. Shridhar, II edition, OHI
Microprocessor Architecture, programming and applications : Ramesh S,. Gaonkar, Wiley Estern Ltd.

M.Sc. (Physics) Semester IV, Elective Paper
Paper XIV : Physics of Nanomaterials

Free electron theory and its features, idea of band structure, metals, insulators and semiconductors, density of states in bands, variation of density of states with energy, variation of density of states and band gap with size of crystal.

Electron confinement in infinitely deep square well, confinement in two and one dimentional well, idea of quantum well structure, quantum dots, quantum wires.

Determination of particle size, X-ray diffraction method, shift in photoluminescence peaks, variations in Raman spectra of nanomaterials.

Different methods of preparations of nanomaterials, precipitation technique, ion beam deposition, cluster beam evaporation, ball milling.

Rererence Books:

Nanotechnology molecularly designed materials : Gan-Moog Chow, Kenneth E. Gonsalves, American Chemical Society.

Quantum dot hetrostructures : D. Bimerg, M. Grundman, N.N. Ledentsov, John Wiely & Sons, 1998.

Nanotechnology : Molecular speculations on global abundance, G.C. Crandall, MIT Press, 1996.

Physics of low dimensional semiconductors : John Davis, Cambridge Univ. Press.

Physics of semiconductor nano structures : K.P. Jain, Narosa, 1997.

Nanofabrication and biosystem : Integrating materials science, engineering science and biology : Harvey Hoch, Harold Craighead, Lynn Jelinski, Cambridge Univ. Press, 1996.

Nanoparticles nano structures films : Preparation, characterization and application, Ed. J.H. Fendler, John Wiley & Sons, 1998.

M.Sc. (Physics) Semester-IV, Elective Paper
Paper XIV : Experimental Techniques in Physics

Nuclear Magnetic Resonance (NMR) spectroscopy, basic principles, nuclear magnetic energy levels magnetic resonance, relaxation processes, continuous wave NMR pulsed (Fourier transform) NMR, spectra and molecular structure, Chemical shifts, Spin-spin coupling, Applications.

Electron Spin Resonance spectroscopy, ESR spectrometer, ESR spectra, Hyperfine interactions g-factor applications.

Mass spectroscopy : principle, spectrometer, and its operation, resolution, Mass spectrum, applications.

Mosbauer Spectroscopy : Mosbauer effect, spectrometer, 57 Fe Mosbauer spectroscopy, nuclear hyperfine interactions.

Intrared Spectroscopy, correlation of IR spectra with molecular structure, Instrumentation, FTIR spectrometer.

Introduction to production of X-ray & X-ray spectra, Instrumentation, X-ray generation, collimators, filters, detectors, X-ray absorption methods, X-ray fluorescence methods, XF – Spectrometer (XFS), Electron spectroscopy for chemical analysis (ESCA), ESCA Spectrometer.

Neutron diffraction, neutron diffractometer (position sensitive diffractometer). Ground based radio techniques, Radar techniques, Rocket and Satellite bome probe and optical techniques for atmospheric & space research.

Books:

Instrumentation Methods of analysis : VIIth Edition, Willard Meritt, Dean, Settle,CBS publishers & distributors.

Mosbauer Sp[ectroscopy : Leopold May, Plenum Press, N.Y.

Neutron Diffraction : G.C. Beeon

X-Ray diffraction : B.D. Culity, Edison Weisley

Techniques for Ionospheric measurements : R.D. Hunsucker (Springer-Venley), 1991.

M.Sc. (Physics), Semester-IV, Special Paper
Paper-XV Space Physics – Elements of Space Technology

Orbital dynamics, Control and Guidance:
Spherical coordinate system, Kepler's laws, sub satellite point, orbital parameters, sun-synchronous and geo-synchronous orbits, low earth orbits, attitude sensors, sun sensors, star sensors, earth sensors, magnetic aspect sensors, accuracies, spin stabilization and gyros, control of flight path, closed loop guidance.

Power Generation and storage:
Space craft power system, special power sources, solar cells and panels, nuclear power, thermoelectric power generation, fuel cells, primary and secondary batteries, controlled harcware.

Rocketry:
Principles of Rocketry, sounding rockets, launchers, rocket fuels, combustion and thrust generation, multistage rockets, Rocket payloads, tracking and telemetry, satellite launch vehicles.

Telemetry and Telecommand:
FM-FM and PCM telemetry systems, signal conditioning, multiplexing, telecommand, pulse and data commands, RF systems, synchronization an demultiplexing, data archival and retrieval, on board and ground segments, real time and off-line processing.

Mechanical, Thermal and payload design aspects:
Mounting of subsystems, rocket nose cone and shrouds, structural and mass limitations, effect of vibration and shocks on space craft structures, honeycomb structures, space craft thermal environment, thermal paint and surface finish, heat dissipation and heat pipes, sensors and signal conditioning electronics reliability considerations, selection of parts, fabrication of electronics sub assemblies, test and evaluation, corona discharge.

M.Sc. (Physics) Semester IV
Paper XV : Material Science (Condensed Matter Physics)

Structure and properties of materials:

Phase diagrams:
Definations and basic concepts. Solubility limit. Phases, microstructure. Phase equilibria. Equilibrium phase diagram. Binary isomorphous systems. Interpretations of phase diagrams Binary eutectic systems. Development of microstructures in a eutectic alloys.Gibbs phase value the iron-carbon system. The Fe-Fe; C Phase diagram, Development of microstructures in iron-carbon alloys, Non-ferrous alloys. Super alloys.

Structure and Properties of Ceramics:
Ceramic structure ceramics density calculations, Sillicate ceramics, carbon diamond, graphite, fullerence, Imperfactions and impurities in ceramics.

Glasses:
Properties of glasses, glass forming. Heat treating glasses glass ceramic. Clay products. Characteristics of clay. Composition of clay products. Refractories. Abrasives. Cement.

Polymers:
Hydrocarbon molecules. Plymer molecules. The chemistry of polymer molecules. Molecular weight and shape. Molecular structure. Molecular configuration. Polymer crystallinity-polymer crystal. Stress-strain behaviour. Deformation of semicrystalline, polymers mechanism. Thermoplastic and thermosetting polymers, visco-elasticity.Deformation of elastomers. Impact strength, fatigue, strength and hardness.

Text Book:

Material Science and Engineering : An Introduction : William D. Callister Jr., John Wielly & Sons.

M.Sc. (Physics) Semester : IV, Special Paper
Paper XV : Electronics-3

Analog Systems:

The differential amplifier, dual input balanced output differential amplifier with swamping resistors, constant current bias.

The basic operational amplifier, block diagram representation of typical op-amp, IC packages.

The ideal op-amp, equavalent circuit of an op-amp, ideal vfoltage transfer curve, open loop op-amp configuration.

Op-amp with negative feedback, voltage series and voltage shunt feedback amplifiers, the practical op-amp, i/p offset voltage and current, i/p bia current, total o/p offset voltage, thermal drift, error voltage, effect of variation in power supply voltage on offset voltage, Noise, CMRR, slew rate.

Linear application, Summing Scaling a averaging amplifiers, subtractor, Integrator, diffrentiater, Active filters, first order low pass and high pass butterworth filter, Square wave, triangular and sawtooth wave generators.

Comparator, zero crossing detection, Schmitt trigger, comparator characteristics, Limitations of Op-amp as comparators, voltage limiters.

Digital Systems:

Combinational logic circuits : design procedures, designing binary adder and subtractor, BCD Excess – 3 code convertder, implementation with gates, designing problems.

Implemention with MSI & LSI : Parallel binary adder, carry propagation delay and look ahead carry generator, magnitude comparator, decoders, BCD to seven segment decoder, multiplexers, Boolean function implementation with decoders and multiplexers.

Sequential logic circuits : Buffer registers, shift registers, bi-directional shift registers, Ring counters, binary counters, Ripple counters, Synchronous counters, Counters with MOD number less than 2N , decade counter, designing of counters.

A/D and D/A converters : Digital to analog conversion, R-2R ladder network, Analog to digital conversion, open-loop methods, flash converter, time window converter, tracking A/D converter, successive approximation converter.

Books:

Digital Electronics : Christopher Strangio, PHI

Fundamentals of Digital Circuits : Anadkumar, PHI, 2002

Digital Logic and Computer Design : M. Morris Mano, PHI.

Digital Systems : Principles and Applications : Ronald Tocci, PHI.

M.Sc. (Physics) Semester-III, Special Paper-III
Paper XV : Sub Atomic Physics (Nuclear and Particle Physics)-3

Neutron Physics and Nuclear Reactor Theory:

Neutron Physics:

Neutrons and its interaction with matter : Nuclear cross section – Microscopic cross section – Macroscopic cross section – Cross section for mixtures.

Slowing down of neutrons : Neutron moderation by elastic scattering – Collision kinematics – Differential elastic cattering cross section – Isotropic scattering –
Average energy loss per collision and average cosine of scattering angle – Double differential scattering cross section – Description of the dynamics of elastic collision in terms of lethargy – Average lethargy gain – Slowing down power and moderation ratio – Average logarithmic energy decrement.

Diffusion of neutrons :Transport theory – Diffusion theory approximation – Calculation of neutron leakage – The diffusion equation – Solution of the diffusion equation – Boundary conditions – The linear extrapolation distance – Diffusion of mono-energic neutrons from a point source – The diffusion length.

Nuclear Reactor Theory:

The fission chain reaction and nuclear reactors : Self sustained chain reaction and reactor criticality – Critical ize and critical mass of a reactor – The multiplication factor – Approximate kinetics of chain reaction – Neutron life cycle and four factor formula – An infinite system – finite system – Nuclear reactors – Classification – General features – Efficiency – thermal reactors.

Critical System : A bare critical reactor – One speed diffusion equation.
Reactor kinetics : Temperature coefficient of reactivity.

Fuel depletion and poisoning effects : Fuel depletion and its consequences – Fission product poisoning – Xenon poisoning – Samarium poisoning.

Radiation protection and environmental effects : Radiation hazards – Different types of radiation – External and internal radiation sources – Radiation Units – The Roentgen and the Rad – The Rem.

Biological effect of radiation : Somatic effects of radiation – Genetic effects of radiation.

Text Books and Reference Books:

S Garg, F. Ahmed, L.S. Kothari, Physics of nuclear reactors, Tata-McGraw Hill.
S.Glasstone and A. Sesonske, Nuclear reactor engineering, CBS publisher & distributors.
J.R. Lamarash, Introduction to nuclear rector theory, Addison Wesely.

M.Sc. (Physics), Semester-IV, Special Paper
Paper-XVI Space Physics – Remote Sensing

Concepts and foundations of Remote Sensing:
Introduction, energy sources and Radiation principles, energy interactions in the atmosphere energy interactions with Earth surface features such as vegetation, water, soil; Reference dasta (Ground truth), An ideal remote sensing system, Characteritics of Real remote sensing systems, Examples of applications of remote sensing.

Elements of Photographic systems:
Early history of Aerial photography, Basic negative to positive photographic sequence, Film exposure, Film density and characteristic curves, structure & Spectral sensitivity of black and white, color and color infrared films, film resolution, Aerial cameras, filters, electronic imaging, multiband imaging.

Principles of photogrammetry:
Basic geometric characteristics of aerial photograph Photographic scale, Area measurement, Relief displacement of vertical features, image parallax, measurement of object height and ground coordinate, Mapping with aerial photographs.

Visual image interpretation:
Fundamentals of visual image interpretation, Basic visual image interpretation equipment, Land use/land cover mapping, Geologic and soil mapping, Forestry mapping, water resources and wetland mapping.

Multispectral and Thermal scanning:
Across tack and along track scanning, Operating principles of multi spectral scanners, Across track thermal scanning, thermal radiation principles, interpreting thermal scanner imagery, Radiometric calibration of thermal scanners. Temperature mapping with thermal scanner data.

Earth Resources satellites:
Early history of space imaging Landsat 1-4 system, Landsat image interpretation, SPOT satellite program, IRS system, data and applications, Meteorological satellites.

Digital image processing:
Introduction, Image rectification and restoration, Image enhancement, contrast manipulation, spatial feature manipulation, image classification, different classification schemes, Classification accuracy assessment, Image transmission and compression.

Text Books for all Space Physics Specialization papers:

Atmospheres and ionospheres of the outer planets and their satellites, Atreya, S.K.

Introduction to Ionospheric Physics, Rishbeth and Garriott, Acad. Press, 1969.

Aeronomy of the middle atmosphere, Brasseur and Solomon, D. Reidel, 1984.

Physics and Chemistry of the upper atmosphere, M.H. Rees, CUP, 1989.

Ionospheric Radio, K. Davies, Peter Peregrinus, (London), 1990.

Radio techniques for probing the Terrestrial ionosphere, R.D. Hunsucker, Springer-Verlag, 1991.

Dynamics of the upper atmosphere, S. Kato, D. Riedel, 1980.

Introduction to Space Physics, S.S. Degaonkar, Gujarat Univ. Press, 1972.

Ionospheric techniques and phenomena, Giraud and Petit, Riedel, 1978.

Solar-Terrestrial environment, J.K. Hargreaves, CUP, 1992.

Introduction to ionosphere and magnetosphere J.A. Ratcliffe, CUP, 1972.

Remote sensing and image interpretation. T.M. Lillesand and R.W. Kiefer (4^{th} ed.) John Wiley and Sons, 2002

Fundamentals of Remote Sensing – George Joseph Univ. Press

Space Craft System Engineering (3^{rd} ed.) Peter & Fortescue et.al. (Eds) John Wiley & Sons, 2003.

Elements of Space Technology, Rudolf Meyer Acad. Press. 1999.

Thrust into Space, Maxwell W. Hunter, Holt. Rienhart & Winston, N.Y.

M.Sc. (Physics) Semester-IV
Paper XVI : Material Science (Condensed Matter Physics)

Structure and Properties of Materials : 2

Composites:

Introduction particle-reinforced composites. Concrete. Fiber-reinforced composities. The matrix phase. Polymer-matrix composites. Processsing of fiber-reinforced composites.

Materials selection and design consideration:
Materials selection for a torsinally tressed cylindrical shaft, Automobile valve spring. Artificial total hip replacement in human body. Thermal protection system on the space shuttle orbital. Materials for integrated circuit packages.

Mechanical Properties of Metals:
Concept of stress-strain. Elastic deformation. Elastic properties of materials. Plastic deformation. Tensile properties ductility. Hardness.

Dislocations and plastic strengthening mechanisms:
Dislocations and plastic deformations. Characteristics of dislocations. Slip systems.Slip in single crystals. Plastic deformation of polycrystalline materials. Deformation by twinning, mechanisms of strengthening in metals by grain size reduction, solid-solution, strain hardening. Recovery, recrystallization and grain growth.

Failure:
Fracture, ductilile fracture. Brilla fracture. Principles of fracture mechanism. Griffith theory of brittle fracture Stress analysis of cracks. Fracture toughness. Fatigue.Cyclic stress. The S.N. curve. Crack initiation and propagation.

Text Book:

Material Science and Engineering : An Introduction : William D. Callister Jr., John Wielly & sons.

M.Sc. (Physics) Semester IV, Special Paper
Paper XVI : Electronics-4

Radio wave propagation, propagation in free space, transmission – path, loss, ground-wave propagation, space-wave propagation, tropospheric propagation, radio horizon 'duct' propagation, sky wave propagation, ionosphere, plasma and critical frequency, secant law and MUF Vertical height, Service range, skip distance, Ionospheric irregularities, fading.

Digital communication, Shannon limit for information capacity, digital amplitude modulation, frequency shift keying, FSK transmitter and receiver, Phase shift keying, BPSK, Quardrature Amplitude modulation (QAM), bandwidth efficiency, carrier recovery, Differential Phase shift keying (DBPSK).

Digital transmission, pulse amplitude modulation (PAM), time division multiplexing of PAM, recovery of TDM – PAM, Pulse widthe modulation (PWM), pulse position modulation (PPM) converting PWM to PPM, pulse code modulation (PCM), Sample and hold circuit, folded binary code, dynamic range, coding efficiency, signal to quantisation noise ratio (SQR), companding.

Optical fiber communication, fiber optic communication link, fiber type, cable construction, propagation of light through optical fiber configurations, signle mode and multi mode slip index fiber, graded-index fiber, Acceptance angle and cone, numerical aperture, losses in optical fiber, Light sources and detectors.

Satellite communication, Orbital and geostationary satellites orbital patterns, look angles, satellite construction, radiation patterns, satellite system link models, transponder, satellite system parameters, brief introduction to multiple – access arrangements (FDMA, TDMA and CDMA). Motible communication, transceivers, radio paging, celluler telephones. LAN, WAN, pocket switching.

Books:

Electronic Communication Systems, Wyne Tomasi, Pearson Education Asia, II Ed. (2001).
Electronic Communication : Modulation & Transmission : Robert J. Schoenbeck, PHI Ed.
Electronic Communication System : George Kennedy TMH.
Electronic Communication Technology, Wilson EA, Prentice Hall.

M.Sc. (Physics) Semester-IV, Special Paper
Paper : XVI Subatomic Physics (Nuclear and Particle Physics)

Strong, Weak and Electromagnetic interactions.

Strong interactions and symmetries :

Uses of symmetry – Space time and internal symmetries – Lie algebra – Casimir operators – SU(2) irreducible representation – Weight diagram – Diagonal generators – SU(3) generators – U and V spin – Raising and lowering operators – Root diagram – Weight diagram – Multiplets of SU(n) – Baryons meson mulplets – Symmetry breaking – Gell-Mann-Okubo mass formula – Charm, bottom and top quarks and higher symmetry – Bag model for hadrons.

Weak and Electromagnetic interactions:

Invariance of Dirac equation – Bilinear covariants – Properties of gamma matrices – Leptonic, semileptonic and nonleptonic weak decays – Selection rule for leptons – Current-currrent interaction and V-A theory – Universality – Abelian and non-Abelian gauge invariance – Spontaneous symmetry breaking and Higgs mechanism – Standard model for electro weak unification.

QCD and Quark – Gluon Plasma

Perturbative QCD I : Colour gauge invariance and QCD Lagrangian – Deep inelastic scattering.
The GLAP equations – an alternative approach to the GLAP equations – Common parametrizations of the distribution functions – Structure Functions The spin – dependent structure functions and the MIT bag model.
Perturbative QCD II : The Drell – Yan process – Small-x physics and the Gribov – Levin – Ryskin equation.
Nonperturbative QCD :QCD sum rules – The ground state of QCD – Equation of state of aquark – gluon plasma – Hadronization phase transition.

Text and Reference Books:

F. Halzen and A.D. Martin, Quarks and Leptons, John – Wiley & Sons, New York, 1984.
G. Kane, Modern Elementary Particle Physics, Addison – Wesley, 1987
D.B. Lichtenberg, Unitary Symmetry and Elementary Particles, 2nd Edition Academic Press, 1978.
R.K. Bhaduri, Models of Nucleon. Addison – Wesley, Reading, MA, 1988.
J. McL. Emmerson, Symmetry, Principles in Particle Physics, Clarendon Press, Oxford, 1972.
M. Leon, An introduction to Particle Physics, Academic Press, New York, 1973.

I.J.R. Aitchison and A.J.G. Hey Gauge Theories of Particle Physics, Adam Hilger, Bristol, 1989.
D.H. Perkins, Introduction to High Energy Physics, Addison – Wesley, London 1982.
W. Greiner and A. Scrnfer, Quantum Chromodynamics, Springer, Berlin, 1993.
D.H. Perkins, Introduction to High Energy Physics, "Addison – Wesley, London, IV Edition, 2000.
F.J. Yndurain. Quantum Chromodynamics – An Introduction to the Theory of Quarks and Gluons. Springer – Verlag New York 1983.

M.Sc. (Physics) Semester-III & Semester-IV
Practicals:

General:

1. R-C Integrating and Differentiating circuits
2. JFET common source amplifier
3. JFET source follower
4. DIAC & TRIAC Characteristics
5. Determination of plateau of G-M Counter
6. Op-amp : Inverting and Non-inverting configurations
7. Study of discrete logic gates ; OR, AND, NAND, NOR using RT and DT logic
8. Diamagnetic susceptibility of a liquid
9. Paramagnetic susceptibility of a liquid
10. Hall effect and its temperature dependence
11. Thermister
12. I-V characteristics of series/parallel combinations and individual of solar cells
13. TTL parameters
14. De Morgan's laws using digital Ics
15. Combinational and sequential logic circuit design
16. Absorption coefficient of beta particles
17. Experiments with He-Ne laser
18. Design of amplifier circuits
19. Op-amp circuits – non-linear applications
20. Ionic conductivity
21. Specific heat of graphite
22. X-ray diffraction : film analysis
23. Characteristics of optoelectronic devices
24. Voltage regulation : series regulator, Zener regulator, IC 317
25. Design of direct coupled amplifier
26. Clipping and Clamping circuits
27. Electron spin resonance spectrometer
28. Study of R-C coupled and feedback amplifier
29. Dielectric constant measurement
30. Experiments using computer on computational methods, computer networking and programming.

Special:
Nuclear Physics:

31. Characteristics of scintillation counter
32. Range of B particles using GM counter
33. Dead time of GM tube by single source method
34. Range and energy of X particles by GM method
35. Pulse height spectroscopy with proportional counter, X-ray & low energy Y-rays

36. Determination of photo peak, Compton edge and backscattering from a mono energetic Y source using scintillation detector.
37. Inverse square law for Y radiation using GM counter
38. Determination of half life by radioactive decay
39. Energy resolution of scintillation spectrometer
40. Measurement of mass absorption and linear absorption coefficient of lead by NAI (TL).
41. Determination of thickness of material by energy loss technique using NAI (TL) detector.
42. Y-Y coincidence bhy scintillation detector
43. Dead time by variable area method
44. Absorption coefficient by equivalent thickness method using GM detector
45. Gating of photopeak using scintillation counter
46. Feather analysis
47. Linear attenuation coefficient for Y rays (GM)
48. Absorption coefficient of different Z materials (NAITL)
49. range and end point energy of B particles by surface barrier detector.
50. Nuclear counting statistics (GM)

Materials Science:

31. Growth of single crystals from melt
32. Growth of single crystals from solution
33. Growth of single crystals from vapour
34. Variation of resistance of Bismuth spiral in a magnetic field
35. Diamagnetic and paramagnetic susceptibility of solids
36. Band gap determination by photoconductivity
37. Indexing of crystal planes by laue method
38. Determination of wavelength of X-rays and absorption coefficient of X-rays
39. Surface roughness by multiple beam interferometry
40. Microindentation hardness of a single crystal
41. Measurement of piezoelectric coefficient
42. Electrical conductivity of ionic solids
43. Dielectric properties of Ba TiO3
44. Electrical reistance of alloys
45. Thermal expansion of solids
46. Thermal analysis of Pb-Sn alloy
47. Study of creep deformation of lead

Space Physics:

31. Stereo test and study of different scales and types of aerial photos
32. Determination of photoscale
33. Determination of heights and reliefs using stereoscope
34. Visual interpretation of various satellite data products on different scales
35. Spectroradiometric observations to measure reflectance characteristics
36. Visual Extraction of thematic information
37. Information extraction through digital image processing
38. Study of communication receiver and signal characteristics

39. Study of ionograms for extraction of critical frequencies and heights
40. Deduction of N-h profiles from ionograms
41. Study of characteristics of a large antenna array
42. Study of quadrature detection using correlation receiver
43. Detection of analysis of radio source signals
44. Study of solar wind – magnetosphere parameters from Solar Geophysical bulletins/internet
45. Interpretation of magnetogram and extraxtion of magnetic elements
46. Study of E and F region irregularities using ionograms
47. Study of C band communication system and its characteristics
48. Computer simulation of trajectory of a rocket and orbit of satellite
49. Measurement of Geomagnetic field by Proton precession magnetometer
50. Airglow measurement using multi-wavelength air glow photometer

Electronics:

31. Monostable multivibrator using transistors
32. Bistable multivibrator using transistors
33. Direct coupled amplifier
34. Schmitt triggere using transistor
35. Clipping and clamping circuits
36. Phase shift oscillator using transistor
37. Phase shift oscillator using JFET
38. SCR characteristics
39. SCR characteristics
40. MOSFET characteristics
41. I.F. tuned amplifier
42. Voltage regulator using emitter follower
43. Op-amp summing, subtracting and logarithmic amplifier
44. Op-amp Wien bridge oscillator
45. Op-amp phase shift oscillator
46. Op-amp integrator and differentiator
47. TTL parameters using digital IC
48. Verification of De Morgan’s theorems
49. Split power supply
50. SMPS power supply
51. Arithmetic circuits using gates
52. Encoders and decoders
53. Combinational logic circuits using decoder, multiplexer
54. Boolean function implementation using ROM
55. Flip-flops using gates and Ics
56. Synchronous & asynchronous counters using Ics
57. Shift registers and ring counters
58. UJT characteristics and relaxation oscillator
59. Experiments on microwaves and their propagation through wave guides using microwave bench
60. Experiments with microprocessor 8085 kit
61. Study of different types of modulation/demodulation
62. Experiments on Fiber Optics and optical fiber communication.