Master of Science

M.Sc.

Semester-III & IV

PHYSICS

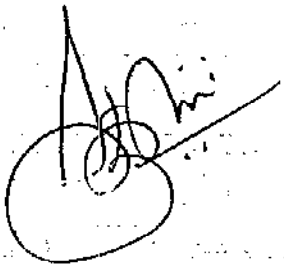
C.B.C.S

Syllabus

DEPARTMENT OF PHYSICS

SAURASHTRA UNIVERSITY

RAJKOT



June: 2011

Dr. Hiren H. Joshi
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M.Sc. PHYSICS

CBCS

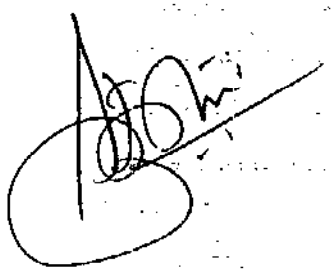
SEMESTER-III and IV

The syllabi for the CBCS: Sem-I and II have already in force since June 2010.

There are two core papers (CT-9 and CT-10) , 12 Elective papers(ET) and 4 interdisciplinary papers(ID) of Sem-III and Sem-IV in CBCS (to be implemented from June-2011) as follows:

The Department will declare the set of elective papers and interdisciplinary papers to be taught in Sem-III and in Sem-IV before commencement of each academic year. The Department will decide a set of Elective and interdisciplinary theory papers to be offered for Semester: III and IV each academic year out of the following list depending upon the availability of expert faculties.

No.	Name of Paper	Paper
1.	CT-9: Nuclear and Particle Physics	Core Paper: SEM:III
2.	CT-10 Numerical Analysis and Computer Programming	Core Paper: SEM:IV
3.	ET-1 : Synthesis of Materials	Elective Paper:SEM: III / IV
4.	ET-2 : Materials Characterization	Elective Paper:SEM: III / IV
5.	ET-3 : Functional Materials	Elective Paper:SEM: III / IV
6.	ET-4 : Physics of Ionosphere-Magnetosphere System	Elective Paper:SEM: III / IV
7.	ET-5 : Remote Sensing and applications	Elective Paper:SEM: III / IV
8.	ET-6 : Space Technology	Elective Paper:SEM: III / IV
9.	ET-7 : Analog and Digital Systems	Elective Paper:SEM: III / IV
10.	ET-8 : Pulse & Microwave Electronics	Elective Paper:SEM: III / IV
11.	ET-9 : Electronic Communication	Elective Paper:SEM: III / IV
12.	ET-10 : Nuclear Radiation Detectors and Accelerators	Elective Paper:SEM: III / IV
13.	ET-11 : Neutron Physics and Nuclear Reactor theory	Elective Paper:SEM: III / IV
14.	ET-12 : Nuclear Reactions, Nuclear Energy and Nuclear models	Elective Paper:SEM: III / IV
15.	ID-1 : Electronic Gadgets and appliances	Interdisciplinary paperSEM: III / IV
16.	ID-2 : Physics and Chemistry of Nanomaterials	Interdisciplinary paperSEM: III / IV
17.	ID-3 : Experimental techniques with Interdisciplinary applications	Interdisciplinary paperSEM: III / IV
18.	ID-4 : Treatment of Experimental Data	Interdisciplinary paperSEM: III / IV



Dr. Hiren H. Joshi
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Rajkot

M. Sc. (Physics)
CBCS
Semester-III

Core Theory Paper : CT-9 Nuclear and Particle Physics

Title of Course:	**Nuclear and Particle Physics**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questi ns from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 8 hours

Basic nuclear properties – Nuclear mass, charge and size – Intrinsic angular mon entum of a nucleus – Dynamic properties of nuclei – nomenclature - Nuclear binding e ergy – Average binding energy per nucleon and saturation of nuclear forces-separation nergy systematic – Abundance systematic of stable nuclides.

Unit-2 9 hour

Liquid drop model- Semi empirical mass formula – mass parabola – liquid drop m del of fission – experimental evidences for shell effects – shell model – spin orbit c upling model– magic numbers – angular momenta and parities of nuclear ground states.

Unit-3 10 hours

Beta de ay – introduction – modes of beta decay- conditions for spontaneous emission of beta de ay- neutrino hypothesis – decay constant for beta decay- Fermi's theory of beta decay – shape of beta spectrum – life time and classification of beta decay – Allowed and forbidd n transitions – selection rules – parity non conservation in beta decay - electron capture lecay – detection and properties of neutrino.

Unit-4 7 hours

Gamm decay – energetics of gamma decay – interaction of gamma rays with matter – internal conversion.
Nuclear reactions – introduction –conservation laws – non relativistic Q –equation – types of nuclear reactions - cross sections.

Unit-5 6 hours

Elemen ary particles – interaction of charge particles with matter - leptons – hadrons – elemen ry particle quantum numbers –isospin - symmetry and conservation laws – Quarks - charm, bottom and top quarks – fundamental interactions.

Referen e Books:

- lements of Nuclear Physics, L.E. Mayerhof, Tata Mc Graw Hill, 1959
- oncepts of modern physics, Arthur Beiser, Mc Graw Hill Inter. 1987
- uclear structure, A.Bohr and B.R. Mottelson, Vol.1 (1969) & Vol.2, Benjamin eading A.(1975)
- troductory Nuclear Physics, Kenneth S. Kiane, Wiley, New York, 1988
- tomic and Nuclear Physics, Vol.2 ,Ghoshal
- troduction to High Energy Physics, P.H. Perkins, Addison-Wesley, London, 982
- uclear Physics Vol. 1 & 2, Shirokov Yudin,Mir Publishers, Moscow, 1982
- troduction to Elementary Particles, D. Griffiths,Har4per and Row, New York, 987
- troduction to Nuclear Physics, H.A. Enge, Addision-Wesley, 1975
- ucleon – Nucleon Interaction, G.E. Brown and A.D. Jackson, North – Holland, msterdam 1976
- uclear Interaction, S. de Benedetti, Hohn Wiley &Sons, New York, 1964
- heory of Nuclear Structure, M.K. Pal, Affiliated East West Madras, 1982
- troductory Nuclear Physics, Y.R. Waghmare, Oxford – IBH, Bombay, 1981
- ementary Particles, J.M. Longo, Mc Graw Hill, New York, 1971
- omic Nucleus, R.D. Evans, Mc Graw Hill, New York, 1955
- uclear Physics, I. Kaplan, 2nd Ed., Narosa, Madras, 1989
- oncepts of Nuclear Physics, B.L.Cohen, TMGH, Bombay, 1971
- uclear Physics, R.R.Roy and B.P. Nigam, Wiley-Eastern Ltd. 1983

M. Sc. (Physics)
CBCS
Semester-IV

Core Theory Paper : CT-10: Numerical Analysis and Computer Programming

Title of Course:	**Numerical Analysis and Computer Programming**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 10 hours

Methods of solving of linear and non-linear algebraic 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.

Unit-2 10 hours

Numerical differential and integration, error estimates. Numerical solutions of ordinary differential equations – Euler and Runge-Kutta methods.
Harmonic Analysis and FFT techniques.

Unit-3 02 hours

Elementary information about digital computers, Introduction to compilers and Operating systems.

Unit-4 14 hours

Programming introduction to FORTRAN, Flow Charts, Data type and structures, Constants and variables, mathematical Expressions in programming, , built in functions, Input and output statements, Logical control statements(with examples), functions and subroutines , operation with files, formatted input and output

Unit-5 04 hours

Programme of straight line fitting, Programme for numerical integration techniques, Harmonic analysis.

Reference Books :

- Numerical Recipes – (CUP)
- Computer Programming In FORTRAN 77– Rajaraman , PHI
- Programming & Computing with FORTRAN 77/90 – P.S. Grover
- Computer based Numerical analysis – Shanthakumar – Khanna Pub.

M. Sc. (Physics)
CBCS
Semester-III / IV
Elective Theory Paper: ET-1: Synthesis of Materials

Title of Course: **Synthesis of Materials**
No. of Credits:03 + 01 (Tutorial & Assignment) = **04**
Teaching hours: 40 hrs
Internal examination,
Preparation and evaluation: 05 hrs

Total Contact hours: 45

Total Marks : 100
External marks: 70
Internal marks: 30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 09 hrs

- **Physical Methods:**
  - **(i) Solid State Reaction (Ceramic) Method:**
    - *General Principles*
    - *Experimental Procedure: Reagents, Mixing, Container Material, Heat Treatment, Analysis*
    - *Kinetics of Solid State Reaction*
    - *Disadvantages*
  - **(ii) Microwave Synthesis:**
    - *Background*
    - *Preparation of $YBa_2Cu_3O_{7-\delta}$ Superconductor through Microwave Synthesis*
    - *Importance*

Unit-2 07 hrs

- **Chemical Routes:**

(i) **Sol-gel Method:**

- *Principle*
- *Lithium Niobate ($LiNbO_3$)*
- *Doped Tin Dioxide*
- *Silica for Optical Fibers*

(ii) **Co-precipitation Method:**

- *Co-precipitation as a precursor to Solid State Reaction*
- *Advantages & Disadvantages*
- *Synthesis of CMR Manganites*

Unit-3 09 hrs

- **Thin Film Synthesis:**
  - *Vacuum Evaporation*
  - *Sputtering*
  - *Spin Coating*
  - *Dip Coating*
  - *Pulsed Laser Deposition (PLD)*
  - *Spray Pyrolysis*
  - *Chemical Vapour Deposition (CVD)*
  -

Unit-4 08 hrs

- **Growth of Single Crystals:**
  - *Czochralski Method*
  - *Bridgman and Stockbarger Methods*
  - *Zone Melting*
  - *Precipitation from Solution or Melt; Flux Method*
  - *Epitaxial Growth of Thin Layers*

Unit-5 07 hrs

- **Vapour Phase Transport Methods**
- **High Pressure & Hydrothermal Methods:**
  - *Background*
  - *Hydrothermal Methods*
  - *Dry High Pressure Methods*

Reference Books:

- Solid State Chemistry and its Applications
  Anthony R. West (John Wiley & Sons)
- Solid State Chemistry – An Introduction
  Lesley Smart and Elaine Moore (Viva Books Private Limited)
- Hand Book of Thin Film Technology
  K. L. Chopra (MacGrow Hill)
- Thin Film Fundamentals
  Goswami A. (New Age International)
- Hand Book of Thin-Film Deposition Processes and Techniques
  Krishna Seshan (Noyes Publications)
- Crystal Growth – A Tutorial Approach
  Eds. W. Bradsley, D.T.J. Hurle & J. B. Mullin (North Holland)
- Crystal Growth Processes & Methods
  P. Santhana Raghavan, P. Ramasamy (KRU Publications)

M. Sc. (Physics)
CBCS
Semester-III / IV
Elective Theory Paper: ET-2: Materials Characterization

Title of Course:	**Materials Characterization**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
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Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 09 hours

X-ray Diffraction:
Introduction, basic principle, Direction of rays, intensity of diffracted X-rays, over view of X-ray diffraction methods.
Powder diffractometer, Effect of crystal size on the powder pattern, particle size measurement, Effect of stress on a powder pattern, Refinement of unit cell parameters and indexing of powder patterns, Powder pattern as a finger print, Structure determination from powder patterns, Powder pattern calculated from crystal structure data, influence of crystal symmetry and multiplicity on powder pattern.

Electron Diffraction:
TEM, electron diffraction mode, analysis

Unit-2 08 hours

Electron Microscopy:
SEM: Physical Basis and primary mode of operation, Instrumentation, Sample requirement, application

TEM : Basic Principle, resolution, Sensitivity, TEM Operation ,Image mode, Specimen preparation

STM and SFM : Introduction, Instrumentation, topography, profilometry, sample requirements

Unit-3 09 hours

Resistivity:
Two point-four point probes, Derivation of four point probe expression, Correction factors, Measurement errors and precautions, factors:- sample size, Carrier injection ,probe spacing, current, temperature, surface preparation, high sheet resistance material, **Van der Pauw method** – measurement of arbitrary shape samples

Dielectric Study: Dielectric materials, types of polarizbilities, dielectric behavior with frequency, introduction to Cole- Cole plot, Ferro-electricity, P-E loop

Unit-4 08 hours

UV-Vis: Introduction, absorbing species, containing π, σ and η electrons, charge transfer absorption, Typical instrumentations, applications

FT-IR: Theory of infrared absorption, vibrational modes, infrared ranges , Fourier transform infrared, instrumentation , use of FT-IR, typical spectral analysis

Unit-5 06 hours

Magnetometry: Basic principle, Vibrating sample magnetometer, SQUID magnetometer
Thermogravimetry: Principle, Apparatus, application, Differential thermal analysis and Differential Scanning Calorimetry, Principles , Apparatus and Applications

Reference books:

- Principles of Instrumental Analysis
  D. A. Skoog and P. M. West
- Spectroscopy
  B. K. Sharma , Goel Publication
- Characterization of Materials
  E. N. Kaufmann, Wiley- Intersciences
- Semiconductor Material and Device Characterization
  D. K. Schroder, IEEE, Wiley Interscience
- Solid State Chemistry and its Applications
  A.R. West , John Wiley Publication
- Encyclopedia of Materials Characterization
  C. R. Brundle, C. A. Evans, S. Wilson Butter Worths
  Heinmann Boston,
- Nano: The Essentials Understanding :Nano Science and Nano-technology
  T. Pradeep , Tata McGrawHill

M. Sc. (Physics)
CBCS
Semester-III / IV

Elective Theory Paper: ET-3: Functional Materials

Title of Course:	**Functional Materials**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
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OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 04 hrs

Fundamental Concepts: Crystallographic structure, chemical structure, bonding, concept of mixed valances, material properties and functional characteristics.

Unit-2 10 hrs

Magnetic Oxide Functional Materials: Diluted magnetic semiconductor (DMS): Origin of ferromagnetism, SPINTRONICS- properties and applications, Magnetic and transfer properties of doped ZnO and Tio_2. **CMR Manganites:** Types of magnetoresistance (MR), Mixed valent manganites, Discovery of colossal magnetoresistance (CMR) effect, Physical properties and crystal structures, Phase diagram of LCMO and LSMO magnites, Doping studies, device applications.

Unit-3 08 hrs

Multiferroics (MFs): Basics, synthesis of MF materials, types of multiferroics, Magneto Electric (ME) effect, $BiFeO_3$ (BFO) multiferroics – synthesis, structure, electric and magnetic properties, applications

Unit-4 10 hrs

High Temperature Superconductor (HTSC): Discovery, Families of HTSC, General feature, Synthesis of YBCO (123) superconductor and crystallographic Structure-property correlations, Role of copper and oxygen, application of HTSC

Unit-5 08 hrs

Ferrites: Fundamentals, Crystal structures, Synthesis methods, properties and applications, Hard and soft ferrites, ferrites compositions for specific applications

Reference books:

- Functional and Smart Materials by Zhong Lin Wang and Z.C. Kang, Plenum Press, 1998 Plenum Publishing Corp
- Colossal Magnetoresistance by C.N.R. Rao & B. Raveau World Scientific, Singapore, 1998
- Superconductivity Today by T.V. Ramakrishnan and C.N.R. Rao University press Hyderabad

M. Sc. (Physics)
CBCS
Semester-III / IV
Elective Paper: ET -4 : Physics of ionosphere-magnetosphere system

Title of Course:	**Physics of ionosphere-magnetosphere system**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
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OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 10 hours

Ionospheric Plasma motions due to applied forces, generation of Electric field, collision frequencies, charged particle motion, response to neutral air wind and electric field, Electrical conductivities

Unit 2 08 hours

Ionospheric conductivity, Ionospheric electric currents, Sq current system. EEJ Peculiarities of low latitude ionosphere, ionospheric storms, irregularities (ESF, scintillation and EEJ irregularities), EIA,

Unit 3 08 hours

Aurora and Airglow: Night glow, Dayglow, Twilight glow, Aurora, Photometer for airglow measurement, applications of Airglow measurement for ionospheric dynamics and composition

Unit 4 10 hours

Magnetosphere:Circulation in the magnetosphere, magentospheric electric fields, particles in the magnetosphere, plasmasphere and its dynamics, magnetospheric current system, magneto pause current tail current ring current and Birlkeland current

Unit 5 04 hours

Magentospheric substorms , substorm triggering and influence of IMF, substorm currents, Whistlers, micro pulsations,

Reference Books:

- The solar terrestrial environment – J K Hargreaves, CUP
- Space Plasma Physics – A C Das, Narosa Pub.

M. Sc. (Physics)
CBCS
Semester-III / IV
Elective Theory Paper : ET-5 : Remote sensing and Applications

Title of Course:	**Remote sensing and Applications**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 :Elements of Photographic systems: 10 hours
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

Unit-2 : Principles of photogrammetry: 08 hours
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.

Unit-3 : Visual image interpretation: 06 hours

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.

Unit-4 : Multispectral and Thermal scanning: 06 hours

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.

Unit-5 : Digital image processing: 10 hours

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

Earth Resources satellites:

Early history of space imaging Landsat 1-4 system, Landsat image interpretation, SPOT satellite program, IRS system, data and applications

Reference Books :

- 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

M. Sc. (Physics)
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Semester-III / IV
Elective Theory Paper : ET-6: Space Technology

Title of Course:	**Space Technology**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit 1 : Orbital dynamics, Control and Guidance: 14 hours
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, altitude control system

Unit 2 : Power Generation and storage: 06 hours
Space craft power system, special power sources, solar cells and panels, nuclear power, thermoelectric power generation, fuel cells, primary and secondary batteries, controlled harcware.

Unit 3 : Rocketry: 08 hours

Principles of Rocketry, sounding rockets, launchers, rocket fuels, combustion and thrust generation, solid and liquid propellent motors, electric propeulsion, multistage rockets,

Unit 4 : Ground based experimental Techniques : 14 hours

Ionospheric sounding, Partial reflection, Scintillation and TEC measurements, airglow photometer, Volume scattering, Coherence and Incoherent scatter, Incoherent scatter radar, MST radar, LIDAR,

Unit 5 : Space borne experimental techniques : 06 hours

Langmuir probe and derivatives, Impedance and resonance probe, Mass spectrometers.

Reference Books :

- The Solar-Terrestrial environment, J.K. Hargreaves, CUP, 1992.
- Spacecraft system engineering – P Fortescue et al , Wiley Pub.

M. Sc. (Physics)
CBCS
Semester-III / IV
Elective Theory Paper : ET-7: Analog and Digital Systems

Title of Course:	**Analog and Digital Systems**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 08 hrs

The basic operational amplifier: block diagram representation of typical op-amp, Schematic symbol IC packages, Op-amp data sheet and op-amp electrical parameters, ideal op-amp, equivalent circuit of op-amp, ideal voltage transfer curve, open loop configurations, Op-amp with negative feedback: Feedback configurations, voltage series feedback amplifier (non-inverting amplifier with feedback), voltage shunt feedback amplifier (inverting amplifier with feedback)

Unit-2 08 hrs

Op-amp circuits:: Summing, Scaling and averaging amplifiers, subtractor, Integrator, differentiator, Active filters, first order low pass and high pass butterworth filters, Band-pass, Band reject and all pass filters, Phase shift and Wien bridge oscillators, Voltage controlled oscillator, Comparator, zero crossing detection, Voltage limiters

Unit-3 08 hrs

Combinational logic circuits : Implementation with gates, design procedure, designing binary adder and subtractor, BCD to Excess – 3 code converter.
Implementation with MSI & LSI : Parallel binary adder, carry propagation delay and look ahead carry generator, 4-bit magnitude comparator, decoders, BCD to seven segment decoder, multiplexers

Unit-4 08 hrs

Sequential logic circuits : Flip-flops, Buffer registers, shift registers, bi-directional shift register, Ring counters, binary counters, Ripple counters, Synchronous counters, Counters with MOD number less than 2N, presettable counter, decade counter

Unit-5 08 hrs

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.

Reference Books:

- Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, PHI
- Digital Electronics : Christopher Strangio ,PHI
- Fundamentals of Digital Circuits : Anadkumar, PHI
- Digital Logic and Computer Design : M. Morris Mano, PHI
- Digital Systems : Principles and Applications : Ronald Tocci, PHI

M. Sc. (Physics)
CBCS
Semester-III / IV
Elective Theory Paper : ET-8: Pulse & Microwave Electronics

Title of Course:	**Pulse & Microwave Electronics**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 08 hrs

Characteristic of Pulse waveforms, rise time, fall time, duty cycle concept, tilt, R-C circuits, constant rate charging, relationship between rise time and upper cutoff frequency, relationship between fall time and tilt, integrating and differentiating circuits. Clipping and clamping circuits using diodes

Unit-2 06 hrs

Schmitt trigger and Ramp generator : Circuit operation, designing for a given upper trigger point (UTP) and lower trigger point (LTP), speed-up capacitor, input and out put characteristics, RC ramp generators, constant current ramp generators

Unit-3 08 hrs

Transistorised multivibrators: Astable, and Monostable multivibrators, Bistable multivibrator with set-reset triggering,
The timer IC-555, functional block diagram, Astable & Monostable multivibrator using IC-555.

Unit-4 10 hrs

Fundamentals of microwave technology, limitations of vacuum tubes. Klystrons, Two cavity Klystron, Multi-cavity and Reflex Klystrons, Traveling wave tube, Magnetron.
Solid-State microwave devices : microwave transistors, Tunnel diodes, Gunn Effect diodes

Unit-5 08 hrs

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: Basic principle, Radar Range equation, Factor influencing maximum range, display methods, moving target indication

Reference Books :

- Solid State Pulse Circuits, David A Bell PHI)
- Electronic Communication Systems : George Kennedy TMH
- Microwave Devices & Circuits, III Edition, Samuel Y. Liao, PHI
- Electronic communications systems, Wayne Tomasi, Pearson Education

M. Sc. (Physics)
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Semester-III / IV
Elective Theory Paper : ET-9: Electronic Communication

Title of Course:	**Electronic Communication**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 06 hrs

Radio wave propagation, propagation in free space, transmission – path, loss, ground-wave propagation, space-wave propagation: radio horizon, sky wave propagation: ionosphere, plasma and critical frequency, secant law and MUF Vertical height, Service range, skip distance

Unit-2 10 hrs

Digital communication, Shannon limit for information capacity, digital amplitude modulation, frequency shift keying, FSK transmitter and receiver, Phase shift keying, BPSK, QPSK, Quardrature Amplitude modulation (8-QAM), bandwidth efficiency
Pulse code modulation (PCM): Sample and hold circuit, dynamic range, companding.

Unit-3 08 hrs

Satellite communication, Orbital and geostationary satellites orbital patterns, look angles, satellite construction, radiation patterns, satellite system link models, transponder, satellite system parameters

Unit-4 10 hrs

Transmission lines and waveguides : Equivalent circuit, primary constants, transmission line equations, infinite line, characteristic impedance, secondary constants, open and short circuited line, line with any termination

Waveguides: Rectangular waveguides, Modes, Properties of TE_{10} mode, generating TE_{10} mode from two TEM waves, fields patterns

Unit-5 06 hrs

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

Reference Books:

- Electronic Communication Systems, Wyne Tomasi, Pearson Education Asia, II Ed. (2001).
- Electronic Communication System : George Kennedy TMH.
- Electronic Communications, Dennis Roddy & John Coolen, PHI
- Modern Electronic Communication, Gray M. Miller & Jeffrey S. Beasley, PHI

M. Sc. (Physics)
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Semester-III / IV
Elective Theory Paper: ET-10: Nuclear Radiation Detectors & Accelerators

Title of Course:	**Nuclear Radiation Detectors & Accelerators**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-I 09 hours

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.

Unit -2 07 hours

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

Unit-3 08 hours

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

Unit -4 08 hours

Historical Developments : Different types of accelerators –Layout and compoents of accelerators – Accelerator applications.
Linear Accelerators : Historical milstones. Fundamental properties of accelerating structures Particle acceleration by EM waves.

Unit -5 08 hours

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

Reference Books:

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

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M. Sc. (Physics)
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Semester-III / IV
Elective Theory Paper: ET-11: Neutron Physics and Nuclear Reactor Theory

Title of Course:	**Neutron Physics and Nuclear Reactor Theory**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 06 hours

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

Unit-2 09 hours

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.

Unit-3 08 hours

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.

Unit-4 10 hours

The fission chain reaction and nuclear reactors : Self sustained chain reaction and reactor criticality – Critical Size 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. Fuel depletion and poisoning effects : Fuel depletion and its consequences – Fission product poisoning – Xenon poisoning – Samarium poisoning

Unit-5 06 hours

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.

Reference Books:

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

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Semester-III / IV
Elective Theory Paper: ET-12: Nuclear Reactions, Nuclear Energy and Nuclear Models

Title of Course:	**Nuclear Reactions, Nuclear Energy and Nuclear Models**
No. of Credits:	03 + 01 (Tutorial & Assignment) = **04**
Teaching hours:	40 hrs
Internal examination, Preparation and evaluation:	05 hrs
Total Contact hours:	**45**
Total Marks :	100
External marks:	70
Internal marks:	30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 08 hours

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.

Unit-2 10 hours

Mechanism of Nuclear Fission, Fission Cross sections, Fission reactors, Fission Rate & reactor Power, Fission neutrons and gamma rays, prompt neutrons, delayed neutrons, fission gamma rays, Fission products, Amounts and activities of fission products, Fission–product activity after shutdown, Heat generation after shutdown

Unit-3 07 hours

Nuclear Fusion – Thermonuclear reactions – Energy production in stars.
Fundamental interactions & elementary particles, Strong, Weak & Electromagnetic interactions.

Unit-4 08 hours

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

Unit-5 07 hours

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.

Reference Books:

- Structure of the Nucleus, M.A. Preston and R.K. Bhaduri, Addison Wesley.
- Nuclear Physics : Theory and Experiments, R. Roy and B.P. Nigam, Wiley Eastern.
- Physics of Nuclei and Particles, P. Marmier and E. Sheldon, Vol.1, Academic Press Physics of the Nucleus, M.A. Preston Addision Wesley.
- Nuclear and Particle Physics, W.S.C. Williams, Clarendon Press.
- Fundamentals of Radiochemistry, D.D. Sood, A.V.R. Reddy, N. Ramamoorthy, Indian association of nuclear chemists & allied scientists.

M. Sc. (Physics)
CBCS
Semester-III / IV
Interdisciplinary Theory Paper: ID-1 Electronic Gadgets and Appliances

Title of Course: **Electronic Gadgets and Appliances**
No. of Credits:03 + 01 (Tutorial & Assignment) = **04**
Teaching hours: 40 hrs
Internal examination,
Preparation and evaluation: 05 hrs

Total Contact hours: 45

Total Marks : 100
External marks: 70
Internal marks: 30

Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 08 hours

Telecommunication systems: Line system characteristics, Radio system characteristics, telephone receivers and hand sets, signaling, modes of operation, station interconnections, The RS-232 interconnecting cable, Various switching systems for telephony

Unit-2 08 hours

Modulation techniques: Analog methods, Amplitude modulation, Frequency modulation, digital methods, ASK, FSK, PSK, Pulse methods: PAM, PWM, PPM, Pulse code modulation(PCM), Multiplexing, Carrier systems: Submarine cables

Unit-3 06 hours

Fiber optics: The telephone network, fiber in local loop, optical systems, types of optical fiber, optical fiber advantages and disadvantages

Unit-4 08 hours

Why digital ?, Digital exchanges, local distribution networks, data services, message services, message switching network, packet switching, packet format, LAN, MAN, WAN, ISDN, The internet, Air-line reservations, BAR codes, Automatic Teller Machines (ATMs)

Unit-5 10 hours

Mobile radio systems: WLL, Radio paging service, call centres, VHF/UHF radio system, Cellular communications, Digital cellular phone block diagram, Facsimile (FAX), Xerography, Calculators, Digital clocks, Microwave ovens, Washing machines

Reference Books:

- Consumer Electronics
  S. P. Bali, Pearson Education
- Modern Electronic Communication
  Gray M. Miller and Jeffrey S. Beasley, PHI

M. Sc. (Physics)
CBCS
Semester-III / IV
Interdisciplinary Theory Paper: ID-2
Physics and Chemistry of Nano-materials

Title of Course: **Physics and Chemistry of Nano-materials**
No. of Credits:03 + 01 (Tutorial & Assignment) = **04**
Teaching hours: 40 hrs
Internal examination,
Preparation and evaluation: 05 hrs

Total Contact hours: 45

Total Marks : 100
External marks: 70
Internal marks: 30
Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit -1 06 hours

Nanomaterials and Nanotechnology: Introduction, Definitions, Emergence, Fabrication Techniques, Challenges, Size Effects, Classification and Applications

Unit -2 08 hours

Nanomaterial Systems - I: (a) Zero-Dimensional Nanostructures: Homogeneous Nucleation, Metallic Nanoparticles, Semiconductor Nanoparticles, Oxide Nanoparticles, Heterogeneous Nucleation, Aerosols Synthesis, Spray Pyrolysis, Template Based Synthesis, Core-Shell Nanoparticles **(b) One-Dimensional Nanostructures (Nanowires):** Spontaneous Growth, Evaporation - Condensation Growth, Vapor - Liquid - Solid Growth, Template Based Synthesis, Electrospinning

Unit -3 08 hours

Nanomaterial Systems - II: (a) Two-Dimensional Nanostructures (Thin Films): Fundamentals of Film Growth, Vacuum Science, Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), Atomic Layer Deposition (ALD), Super Lattices, Self Assembled Monolayers, Electrochemical Deposition, Sol-Gel Synthesis **(b) Special Nanomaterials:** Carbon - Fullerenes and Nanotubes, Micro and Mesoporous Materials, Core - Shell Structures, Organic – Inorganic Hybrids, Nanocomposites and Nanograined Materials

Unit -4 10 hours

Nanomaterial Characterization Techniques: Structural Characterization: X-Ray Diffraction (XRD), Small Angle X-ray Scattering (SAXS), Scanning Electron Microscopy (SEM), Focused Ion Beam (FIB), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM) **Chemical Characterization:** Optical Spectroscopy, Electron Spectroscopy, Photoelectron Spectroscopy (PS), Vibrational Spectroscopy, Dynamic Light Scattering (DLS), Ionic Spectrometry **Physical Properties:** Mechanical and Optical, Electrical Conductivity, Ferroelectric and Dielectric, Superparamagnetism

Unit -5 08 hours

Applications of Nanomaterials: Molecular and Nano Electronics: Molecular Motors, Molecular Devices, Single Molecular Devices **Nanotribology:** Nano Tribometer, Surface Force Apparatus, Quartz Crystal Microbalance, Superlubricity, Hard Disk Capacity, Micro-Electromechanical Systems (MEMS) **Nanosensors:** Nanoscale Organization, Self-Assembly, Quantum Size Effects, Electrochemical Sensors, Nano-Bio-Sensors, Future **Nanomedicines:** Developments, Various Nanosystems in use, Diagnostic and Therapeutic Applications

Reference Books:

- Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Guozhong Cao, Imperial College Press (Distributed by World Scientific Publishers, Singapore)
- Nano - The Essentials: Understanding Nanoscience and Nanotechnology by T. Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi
- Nanophysics and Nanotechnology by Edward C-Wolf, Wiley – VCH
- Introduction to Nanotechnology by Charles P. Poole Jr. and Frank J. Owens, Wiley Interscience
- Introduction to nano-science & nano-technology by K.K.Chattopadhyay and A.N. Banerjee, PHI

M. Sc. (Physics)
CBCS
Semester-III / IV
Interdisciplinary Theory Paper: ID-3
Experimental Techniques with Interdisciplinary Applications

Title of Course: **Experimental Techniques with Interdisciplinary Applications**
No. of Credits:03 + 01 (Tutorial & Assignment) = **04**
Teaching hours: 40 hrs
Internal examination,
Preparation and evaluation: 05 hrs

Total Contact hours: 45

Total Marks : 100
External marks: 70
Internal marks: 30
Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1 09 hours

Radiation sources, Radiation interactions, Radiation detectors- gas filled detectors – scintillation detectors – semiconductor detectors.

Unit-2 09 hours

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),

Unit-3 07 hours

Nuclear Magnetic Resonance (NMR) spectroscopy, basic principles, nuclear magnetic energy levels, magnetic resonance, NMR Spectrometer.
Electron Spin Resonance spectroscopy, ESR spectrometer, ESR spectra, Hyperfine interactions.

Unit 4 07 hours

Mass spectroscopy : principle, spectrometer, and its operation, resolution, Mass spectrum, applications.
Intrared Spectroscopy, correlation of IR spectra with molecular structure, Instrumentatio.

Unit-5 08 hours

Mosbauer Spectroscopy : Mosbauer effect, spectrometer, 57 Fe Mosbauer spectroscopy, nuclear hyperfine interactions.
Neutron diffraction, neutron diffractometer (position sensitive diffractometer) .

Reference Books:

- Instrumentation Methods of analysis : VIIth Edition, Willard Meritt, Dean, Settle,CBS publishers & distributors.
- Mosbauer Spectroscopy : Leopold May, Plenum Press, N.Y.
- Neutron Diffraction : G.C. Becon
- X-Ray diffraction : B.D. Culity, Edison Weisley
- Radiation Detection & Measurment : Glenn F. Knoll

M. Sc. (Physics)
CBCS
Semester-III / IV
Inter Disciplinary Paper : ID-4 : Treatment of Experimental Data

Title of Course: **Treatment of Experimental Data**
No. of Credits:03 + 01 (Tutorial & Assignment) = **04**
Teaching hours: 40 hrs
Internal examination,
Preparation and evaluation: 05 hrs

Total Contact hours: 45

Total Marks : 100
External marks: 70
Internal marks: 30
Structure of Semester end Examination:
Maximum marks: 70
Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks

Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Detailed Syllabus:

Unit-1

10 hours

Types of data series, time series, plotting and presentation of data, chart types, X-Y scatter, bar, line and pie charts, contours plotting

Unit-2

10 hours

Characteristics of probability distribution, cumulative distribution, expectation value, standard deviation, distribution moments, the mean variance, the covariance, Binomial distribution, Poisson distribution, Gaussian distribution, Chi-Square distribution, Measurements of errors

Unit 3 04 hours

Sample and parameter estimation, sample moments, the maximum likelihood method, estimator foe various distributions, the weighted mean

Unit 4 10 hours

Example of applications, mean and errors from a series of measurements, combining data with different errors, determination of count rate and errors, use of standard software package with examples

Unit 5 06 hours

Curve fitting, the least square method, linear fits, linear fit with both variables having errors, non linear fits, spectral analysis of time series data

Reference Books :

- Techniques of Nuclear and Particle.Physics Experiments- W R Leo, Springer-Verlag 1992
- Any reference book on MS Office for chart plotting