

***POST GRADUATE DEPARTMENT OF PHYSICS
UNIVERSITY OF KASHMIR, SRINAGAR - 6***



M. Sc. Physics (IV Semester)

***Course Curriculum (Syllabus for examination)
for the academic years***

2014

Semester-IV

S. No.	Subject Code	Subject Name	Total Max. Marks	Total Min. Marks	Internal Max.	Internal Min.	External Max.	External Min.
01	PHYP13401	Project	200	80	100	40	100	40
02	PHYS13402	Quantum Electrodynamics	100	40	20	08	80	32
03	PHYS13403	Materials Science	100	40	20	08	80	32
04	PHYS13404	Atmospheric Physics	100	40	20	08	80	32
05	PHYS13405	Advanced Particle Physics	100	40	20	08	80	32
06	PHYS13406	Astrophysics-II	100	40	20	08	80	32
07	PHYS13407	Antenna and Wave Propagation	100	40	20	08	80	32
08	PHYS13408	Physics of Nanomaterials	100	40	20	08	80	32

SEMESTER: IV

(Course of Study for the year 2014, 2015, 2016)

Students have to choose any four papers from the special courses PHY-S402 onwards. The project course PHY-P401 is compulsory for all the students.

Course No.	Title of the Course
PHYP13401	Project
PHYS13402	Quantum Electrodynamics
PHYS13403	Material Science
PHYS13404	Atmospheric Physics
PHYS13405	Advanced Particle Physics
PHYS13406	Astrophysics-II
PHYS13407	Antenna and Wave Propagation
PHYS13408	Physics of Nanomaterials

Semester - IV
Quantum Electrodynamics

Course No.: PHYS13402

Max. Marks:100

Duration of Examination: 2.30 hrs.

(a) External Examination: 80

No. of Lectures: 45-60

(b) Internal Assessment: 20

(Valid for session 2014)

UNIT I

Lorentz Covariance of the Dirac Equation: Covariant form of the Dirac equation, Proof of Covariance, Space Reflection, Bilinear Covariants, Solution of the Dirac Equation for a free particle: Plane wave Solutions, Projection Operators for Energy and Spin, Physical Interpretations of Free-particle solutions and packets.

UNIT II

The Foldy-Wouthuysen Transformation: Introduction, Free-particle Transformation, The Hydrogen atom

Hole Theory: The problem of Negative Energy Solutions, Charge Conjugation, Vacuum Polarization, The time Reversal and other Symmetries

UNIT III

General Formulation of the Quantum Field Theory: Implication of the Description in Terms of Local Fields, Canonical Formulation and Quantization Procedure for particles, Canonical Formulation and Quantization for Fields, The Klein-Gordon Field: Quantization and Particle Interpretation, Symmetry of the States, Measurability of the Field and Microscopic Causality, Vacuum Fluctuations, The Charged Scalar Field, Feynman Propagator

UNIT IV

Second Quantization of the Electromagnetic Field: Quantum Mechanics of N-identical Particles, The Number Representation for Fermions, The Dirac Theory, Momentum Expansions, Relativistic Covariance, The Feynman Propagator

Quantization of the Electromagnetic Field: Introduction, Quantization, Covariance of the Quantization Procedure, Momentum Expansions, Spin of the Photon, The Feynman Propagator for Transverse Photons

Text and Reference Books:

1. Bjorken & Drell: "Relativistic Quantum Mechanics"
2. Bjorken & Drell: "Relativistic Quantum Fields"
3. Schweber, Bethe and Hoffmann: Mesons and Fields
4. Sakurai: Advanced Quantum Mechanics

5. Lee: Particle Physics and Introduction to Field Theory

Semester- IV
Materials Science

Course No.: PHYS13403

Max. Marks:100

Duration of Examination: 2.30 hrs.

(a) External Examination: 80

No. of Lectures: 45-60

(b) Internal Assessment: 20

(Valid for session 2014)

UNIT 1

Introduction: Brief review of modern atomic structure, chemical bonds and their types. Crystallography: Concept of unit cell, space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density, Miller indices, X-ray crystallography techniques, Concept of amorphous, single and polycrystalline structures and their effect on properties of materials. Crystal growth techniques in general.

UNIT II

Diffusion: Fick's laws and application of diffusion in sintering, doping of semiconductors. Metals and Alloys: Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, inter-metallic compounds, iron-iron carbide phase diagram, Recrystallization and grain growth, Microstructure, properties and applications of ferrous and non-ferrous alloys.

UNIT III

Ceramics: Structure, types and properties, Applications of ceramics, processing of Ceramics, Solid state reaction technique, Magnetic and electrical properties of ceramics.

Plastics: Various types of polymers/plastics and its applications. Mechanical behavior and processing of plastics, Future of plastics, Composite Materials and their uses. Smart materials, exhibiting ferroelectric, piezoelectric, opto-electric, semiconducting behavior, Lasers and optical fibers, photoconductivity.

UNIT IV

Brief introduction to Nano-materials, synthesis, properties and applications. Super-alloys, shape memory alloys. Materials characterization techniques, X-ray diffraction; single crystal and powder method. Scanning electron microscopy, transmission electron microscopy, scanning tunneling microscopy. Thermal analyses, thermogravimetric analysis, differential scanning calorimetry. Infra-red and Raman spectroscopy.

Text & Reference Books:

1. William D. Callister Jr. , David G. Rethwisch, Materials Science & Engineering. 8th Edition, John Wiley and Sons.
2. James F. Shackelford, Introduction to Materials Science for Engineers (7th Edition) Prentice Hall.
3. Van Vlack , Elements of Materials Science & Engineering, 6th Edition, Prentice Hall.

Semester - IV
Atmospheric Physics

Course No.: PHYS13404

Max. Marks:100

Duration of Examination: 2.30 hrs.

(a) External Examination: 8

No. of Lectures: 45-60

(b) Internal Assessment: 20

(Valid for session 2014)

UNIT I

Origin, Composition and Mean Structure of the Atmosphere, Atmospheric oxygen and life, Vertical profiles of pressure and density, Variable constituents, The vertical temperature structure, Temporal and latitudinal variability,

General Circulation of the Atmosphere, Energy Balance of the Earth, Global Patterns of Insolation, Heating Imbalances, Earth's Energy Budget, Surface Energy Budget

Modeling Energy Balance, Global Heat Balance, Atmosphere's Energy Budget, Natural Greenhouse Effect, Effect on Surface Temperature

Unit II

Gas law and its application to dry air, water vapour, and moist air, Virtual Temperature, Hydrostatic Equation, Geopotential, Scale Height, hypsometric equation, Reduction of Pressure to Sea Level, specific heat, adiabatic and isothermal processes, concept of air parcel, dry adiabatic lapse rate, potential temperature, first law thermodynamic applied to atmosphere, Moisture Parameters, potential temperature, Clausius Clapeyron equation, latent Heats, Saturated Adiabatic and Pseudoadiabatic Processes, The Saturated Adiabatic Lapse Rate, Equivalent Potential Temperature and Wet-Bulb Potential Temperature, Stability and instability, parcel and slice method

Unit III

Earth coordinate system (latitude, longitude, depth), Dynamic and thermodynamic variables (u,v,w,T,P,density). Forces felt by an air parcel, mathematical development of apparent forces, momentum equations, scale analysis momentum equations, the Rossby Number and geostrophic, Cyclostrophic and gradient Balance, Continuity equation, Energy equation, Governing equations for synoptic scale. The Thermal Wind, Vertical motion, pressure coordinates, Basic equations in pressure coordinates, linearizing governing equations

Unit IV

Weather and climate, weather forecasting, Numerical weather prediction models, Global climate models, Working principle, application and circuit descriptions in blocks of the system: Ionosonde, Rdiosonde, Ozonesonde, LIDARS, DIAL, SODARS, AWS, weather Satellites, Doppler Radar, ST Radar and MST radar

Text and Reference Books:

1. McIlveen, R., Fundamentals of Weather and Climate, Chapman-Hall, 1992
2. An Introduction to Dynamic Meteorology (3rd edition), J.R. Holton
3. Atmospheric Science: An Introductory Survey by J.M. Wallace and P.V. Hobbs, Academic,
4. 1977, Hargrave Library 551.5 W191A.
5. The Physics of Atmospheres by J.T. Houghton, 1986,
6. Theory of Satellite Orbit in the Atmosphere by King Hele
7. Numerical Analysis by Shastri
8. Weather Satellite by L.F. Hubert
9. Meteorological Satellite by W.K. Widger
10. A guide to Earth Satellite by D. Fishlock

Semester – IV
Advanced Particle Physics

Course No.: PHYS13405

Max. Marks:100

Duration of Examination: 2.30 hrs.

(a) External Examination: 8

No. of Lectures: 45-60

(b) Internal Assessment: 20

(Valid for session 2014)

UNIT I

Elementary Particles and Elementary Particle dynamics, Four forces, Quantum Electrodynamics(QED), Quantum Chromodynamics(QCD), Weak Interactions, Decay of Muon, Decay of Pion, Parity violation, Charge conjugation, Time Reversal, Baryon Ground States, Excited States and Resonances, Excited State of Baryons, Parton model and Bjorken Scaling

UNIT II

Interactions and Nuclear Cross Sections, Classification and response of Particles to Interactions, Strong Interaction, Electromagnetic Interactions, Weak Interactions, Nuclear Potentials, One-pion exchange potential, One-boson exchange potential, Nucleon-nucleon interaction for bound nucleons, Relation with Quark-Quark Interaction, Electrodynamics of Quarks and Hadrons, Deep Inelastic Electron-Proton Scattering

UNIT III

Evidence of Quarks, The Basic Building Block of Hadrons, Isospin of Quarks, Particles and anti-particles, Static Quark Model of Hadrons, Hadron Mass and Quark-Quark Interaction, Eightfold way, Quark Model, Baryon decuplet, Meson Nonet, Standard Model, First generation, Second generation and third generation Quark, Mesons as Bound Quark States, Baryons as Bound Quark States

UNIT IV

Physics and Astrophysics of Quark Gluon Plasma(QGP): Glauber Model of Nucleus-Nucleus collisions, Bag model, High temperature scenario, High Baryon Density Scenario, Quark Gluon Plasma, Hydrodynamics of Quark Gluon Plasma, Phase Transition and Hadronization. Signatures of QGP, Dilepton Production, J/Psi production and suppression, Strangeness Enhancement, Photon Production, Direct Photons

Text and Reference Books:

1. Nuclear and Particle Physics-An introduction by B.R. Martin (Wiley Publication) or

2. Physics of Nuclei and Particles-Marmier and Sheldon (Vol-I & II) Academic Press New York and London.
3. F.Halzen and A.D. Martin, Quarks and Leptons, John – Wiley & Sons, New York. 1984
4. G.Kane, Modern Elementary Particle Physics, Addison – Wesley, 1987
5. D.B.Lichtenberg, Unitary Symmetry and Elementary Particles, 2nd Edition, Academic Press, 1978
6. R.K.Bhaduri, Models of Nucleon, Addison – Wesley, Reading MA, 1988
7. J.McL. Emmerson, Symmetry Principles in Particle Physics, Clarendon Press, Oxford, 1972

Semester - IV
Astrophysics - II

Course No.: PHYS13406

Max. Marks:100

Duration of Examination: 2.30 hrs.

(a) External Examination: 80

No. of Lectures: 45-60

(b) Internal Assessment: 20

(Valid for session 2014)

UNIT I

Stellar dynamics, types of forces on a star in the stellar system, Tidal radii, star star encounter, time of relaxation determination of time of relaxation, application to Galaxy & star cluster

Masses of double galaxies, Masses of cluster of galaxies by virial theorem observational determination of masses, clusters of galaxies, Missing mass problem

UNIT II

Cosmology, cosmological principle, Newtonian cosmology, deceleration parameters critical density, Robertson walker equation and its properties, solution of Robertson-Walker equations. Einstein field equation in cosmology, Energy tensor of Universe, solution of Friedman's equation, Einstein de-sitter model, open model, particle horizon, Event horizon

UNIT III

The formation of structures in the Universe: Jean's equation derivation from fluid dynamics and General relativity; evolution of Jean mass, Growth in the Post recombination era; Einstein-do Sitter model; closed model; open model; observation constraints; small angle anisotropy, horizon problem, the scale – invariant spectrum, Hierarchy of structures, Age distribution

UNIT IV

Thermal History of the Universe, Temperature red shift relation, distribution in the early Universe, relativistic and non-relativistic limits, decoupling of matter and radiation, Cosmic microwave background radiation (CMBR), isotropy and an- isotropy of CMBR

Text and Reference books:

1. Introduction to Cosmology By J.V. Narliker
2. Structure Formation in the Universe by T. Padmanabhan, vumbridge University
3. Stellar Dynamics by S. Chandersakher
4. Stellar Evolution by Kippenhahn
5. Quassars and Active Galactic Nuclei by A. K. Kembehavia & G. V. Narliker, Cambridge University Press
6. Modern Astrophysics by B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.

Semester- IV
Antenna and wave propagation

Course No.: PHYS13407

Max. Marks:100

Duration of Examination: 2.30 hrs.

(a) External Examination: 80

No. of Lectures: 45-60

(b) Internal Assessment: 20

(Valid for session 2014)

Unit I

Antenna Fundamentals and Definitions: Radiation mechanism - over view, Electromagnetic Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation Patterns, Directivity and Gain, Antenna Impedance, Radiation Efficiency. Antenna Polarization Resonant Antennas: Wires and Patches, Dipole antennas, Yagi - Uda Antennas, Micro strip Antenna

Unit II

Arrays: Array factor for linear arrays, uniformly excited, equally spaced Linear arrays, pattern multiplication, directivity of linear arrays, non- uniformly excited -equally spaced linear arrays, Mutual coupling, multidimensional arrays, phased arrays, feeding techniques, perspective on arrays. Broad band Antennas: Traveling- wave antennas, Helical antennas, Biconical antennas; Principles of frequency - independent Antennas, spiral antennas, and Log - Periodic Antennas

Unit III

Aperture Antennas: Techniques for evaluating Gain, reflector antennas - Parabolic reflector antenna principles, Axi -symmetric parabolic reflector antenna, offset parabolic reflectors, dual reflector antennas, Gain calculations for reflector antennas, feed antennas for reflectors, field representations, matching the feed to the reflector, general feed model, feed antennas used in practice

Unit IV

INTELSAT Series, INSAT, VSAT, Remote sensing, Mobile satellite service: GSM. GPS, INMARSAT, Satellite Navigation System, Direct to Home service (DTH), Special services, E-mail, Video conferencing and Internet connectivity

Text & Reference Books:

1. Stutzman and Thiele, "Antenna Theory and Design", 2ndEd, John Wiley and Sons nc
2. C. A. Balanis: "Antenna Theory Analysis and Design", John Wiley, 2nd Edition, 1997
3. Bruce R. Elbert," The Satellite Communication Applications Hand Book, Artech House Boston, 1997
4. Antenna Hand book by J. D. Kraus

Semester- IV
Physics of Nanomaterials

Course No.: PHYS13408

Max. Marks:100

Duration of Examination: 2.30 hrs.

(a) External Examination: 80

No. of Lectures: 45-60

(b) Internal Assessment: 20

(Valid for session 2014)

Unit I

Introductory Aspects: Free electron theory and its features, Idea of band structure metals, insulators and semiconductors. Density of state in bands and its variation with energy, Ef-fect of crystal size on density of states and band gap. Examples of nanomaterials

Unit II

Preparation of Nanomaterials and General Characterization Techniques Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling

Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning forcemicroscopy

Unit III

Quantum Dots: Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, quantum dots - single and interacting quantum dots, self organized quantum dots, spectroscopy of quantum dots

Unit IV

Other Nanomaterials: Properties and applications of carbon nanotubes and nanofibres, Nanosized metal particles, Nanostructured polymers, Nanostructured films and Nano structured semiconductors

TUTORIALS: Relevant problems pertaining to the topics covered in the course

Text & Reference Books:

1. Nanotechnology - Molecularly Designed Materials : G.M. Chow & K.E.Gonsalves (American Chemical Society).
2. Nanotechnology Molecular Speculations on Global Abundance : B.C. Crandall (MIT Press).
3. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley).
4. Nanoparticles and Nanostructured Films-Preparation, Characterization and Application : J.H. Fendler (Wiley)

Note:

1. A minimum number of 45 lectures to be delivered by the teacher
2. *The question paper consists of three sections A, B and C covering all the four units.*
3. Attempt all questions from Section A & B and only two questions from section C
4. Section A: very short answer type questions (8 questions; marks $8 \times 2 = 16$) giving answer in about 10 – 20 words
5. Section B: short answer type questions (4 questions; marks $4 \times 8 = 32$) giving answer in about 200 – 250 words.
6. Section C: long answer type questions (4 questions; marks $2 \times 16 = 32$) giving answer to any two questions in about 400 – 500 words.
7. Duration of question paper will be 2.30 hrs.
8. The course will be valid for the years 2013, 2014 and 2015 for the I & II Semesters and 2014, 2015 & 2016 for III & IV Semesters.

Semester – IV
Paper: Project

PHYP13401 (Project)

Max. Marks: 200

(a) External Examination: 100

(b) Internal Assessment: 100

(Valid for session 2014)

- The course related to project is based on the preliminary research oriented topics both in theory and experiment.
- The teachers who will act as Supervisors for the projects will float different projects (theoretical/experimental) for the IV Semester students in their respective specialization. These projects will be discussed and finalized in the Committee consisting of the Departmental Research Committee members and all the concerned supervisors. The approved list of projects will be displayed for the IV Semester.
- All the M.Sc. IV Semester students will be asked to choose projects out of the approved list prepared by the department. Four students will be asked to choose one project from their specialization. In case there are less than four students in any specialization, they can combine to have same project.
- The IV Semester students will work regularly on the project during working hours of Laboratory Courses and their attendance will be marked by the concerned Supervisor.
- Each group (with same Project topic) will submit two copies of the project in the form of Dissertation to the Head, Department of Physics within two months of the completion of IV semester theory classes.
- The dissertation will be sent to the examiners for evaluation by Head of the Department. The examiners will be requested to evaluate the dissertation within three to four weeks. The Viva-voce examination of project will be held after receiving the dissertation report of the external examiner.
- The final examination of the project consists of :
 - (a) Presentation
 - (b) Comprehensive Viva-Voce

- The project will be of 200 marks and the distribution of marks will be as under:

Internal Assessment by the panel of Examiners: *100 marks*

Viva-voce examination:

Head, concerned Supervisor & External Examiner *50 marks*

Presentation of Project:

Head, concerned Supervisor & External Examiner *50 marks*

- The concerned Supervisor of the project will identify the Centre of Excellence/Institute outside the valley in their specialization for Practical Training programme for students for three weeks. The concerned supervisor will finalize the practical training programme in consultation with the concerned institute.
- All students shall visit the institute for data collection/library consultation/experimental training etc. at the end of IV Semester.
- The experimental work/ Data Collection/Library Consultation etc. in different Institutes outside the valley is a compulsory component of project work for the 4th Semester students.