SCHEME OF EXAMINATION

&

SYLLABUS OF

M.Phil. (PHYSICS)

UNDER

FACULTY OF SCIENCE

Approved by Board of Studies in Physics

EFFECTIVE FROM JULY 2017

School of Studies in Physics & Astrophysics
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Approved by Board of Studies in Physics on 10, February 2017
PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR

M.Phil. - PHYSICS

The Master of Philosophy (M Phil) in Physics is a full time course for one year after completion of M Sc in Physics. Admission to M.Phil. (Physics) programme will be done through entrance examination.

The course structure will contain three Theory Papers and Dissertation, Three Seminars and Two internal examinations/assessments as outlined below.

Name of the Paper	Marks
1. Research Methodology, Quantitative Methods and Computer Applications	100
2. Physics of Advance Materials	100
3. Astronomy & Astrophysics	100
Dissertation & Seminar	200
Total Marks	500

Distribution of marks of Dissertation and seminar

(i) Seminar (best two out of three) : 50 marks

(ii) Dissertation : 150 marks
(a)Final Seminar based on dissertation : 50
(b)Dissertation (script) evaluation : 75
(c) Viva-voce : 25

Paper – I
Research Methodology& Quantitative Methods and Computer Applications

UNIT- I
Techniques for Structural, Microscopic, and Spectroscopic Characterization

X-ray diffraction: coherent scattering of X-rays, reflected intensities, experimental methods of crystallography, particle size determination.
Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Transmission Electron Microscopy (STEM), Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM).
Spectroscopy: Fourier Transform Infrared (FTIR) and Raman spectroscopy, Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR).

UNIT – II
Techniques for Characterization of Solid State Ionic and Luminescent Materials

Solid State Ionic Materials: Characterization of ion transport properties; AC Impedance Spectroscopy (IS) for conductivity of (σ) measurements; DC polarization methods viz, Tubandt's method, Wagher's method, Transient Ionic Current (TIC) method for ionic mobility (μ), ionic transference number (t_{ion}),mobile ion concentration (n) and ionic drift velocity (v_d) measurements. Temperature dependent studies on σ, μ, n, v_d etc. and computation of respective energies.
Techniques for ML measurement and TL measurements. Measurement techniques to study Photoluminescence response, UV-visible spectrometry.
Thermal analysis: Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Thermal Gravimetric Analysis (TGA).

UNIT – III
Astrophysical Techniques for Astronomical Observations

Photometry: Instrumental magnitudes and colors, seeing and atmospheric effects, extinction correction. Standard photometric systems: UBV and other systems. Transformation to a standard photometric systems. Absolute and differential photometry.
Spectroscopy: Basics of prism and grating spectroscopes.
Basics of CCD data reduction: Plate scale, readout noise and gain, signal-to-noise ratio. correction for bias, dark and flat fielding, fringing and cosmetic effects.

UNIT – IV

(I) Programming in C

Getting Started: Elementary idea about C Language, Getting Started with C,the First C Program, Compilation and Execution, Receiving Input; C Instructions: Type Declaration Instruction, Arithmetic Instruction, Integer and Float Conversions, Type Conversion in Assignments, Hierarchy of Operations, Associativity of Operators. Control Instructions in C.

Control Structures: The Decision Control Structures If Statement, If-else Statement, Use of Logical Operators, The Conditional Operators. **The Loop Control Structure:** Loops, the while Loop, the for Loop, the Odd Loop, the break Statement, the Continue Statement, the do-while Loop. **The Case Control Structure:** Decisions Using switch, switch Versus if-else Ladder The go to Keyword.

UNIT – V

(II) Programming in C

Functions & Pointers : What is a Function, Passing Values between Functions, Scope Rule of Functions calling Convention, Advanced Features of Functions; Function Declaration and Prototypes Call by Value and Call by Reference , An Introduction to pointers, Pointer Notation, Back to Function Calls, Conclusions.

Storage classes in C: Automatic Storage Class, Register Storage Classes, Static Storage Classes, External Storage Classes, Which to Use When.

The C Preprocessor: Features of C Preprocesor, Macro Expansion, File Inclusion, Conditional Compilation, #if and #elif Directives, Miscellaneous Directives.

Arrays: What are Arrays; A Simple Program using Array. More on Arrays; Array Initialization, Bounds Checking, Passing Array Elements to a Function. Pointers and Arrays; Passing an Entire Array to a Function.

Recommended Text and Reference books:

1. Characterization of Materials: Wachtman J B (Butterworth-Heinemann)
2. Introduction to Nanotechnology by Charles P. Poole Jr. and Frank J. Owens (Willey Inter. Science Pub. 2003)
3. Condensed Matter Physics by Michal P. Marder (Willy Inter. Science Pub., 2000)
4. Superionic Solids- Principle and applications by S. Chandra (NH Pub., 1980)
5. Luminescence of Solids : R Vij (Plenum Press)
6. Digital Image processing: Gonzalez R. C. and Woods R. E. (Addision-Wesley)
7. Astronomical Photometry: Henden A. A. and Kaitchuck R H (Willmann-Bell)
8. Astrophysical techniques: Kitchin C R , third edition (IOP publishing)
9. Optical Astronomical Spectroscopy: Kitchin C R (IOP Publishing).
10. Let us C by Yaswant Kanitkar
11. C Programming by Dennis Riche and Brian Karnighan
12. C Programming by Schauam Series

Paper II
Physics of Advance Materials

Unit I
Nano Particles and Nano Structured Materials

Properties of Individual Nano-Particle: metal nano clusters, theoretical modeling of nanoparticles, geometric and electronic structure, magnetic clusters, Semiconductor nanoparticles, optical properties, rare gas and molecular clusters, methods of synthesis of nano particles, Carbon nanostructure, C_{60} carbon cluster, carbon nanotube and applications. Bulk nano structured materials: Solid disordered nanostructures, methods of synthesis, properties, metal nano-cluster composite glasses, porous silicon; Nano structured crystals.

Unit II
Quantum Nanostructures and Nano- Machines/ Devices

Quantum wells, wires and dots, preparation, size & dimensionality effects, excitons, single electron tunneling, applications of quantum nanostructures, Super conductivity, Self assembly, process of self assembly, semiconductor islands, monolayers, Catalysis, surface area of nanoparticles, porous, and colloidal materials, Nanomachines and nano devices; microelectromechanicalsystems (MEMSs), nanoelectromechanicalsystems (NEMSs).

UNIT III
Solid State Ionic Materials

Bonding types in solids, formation of ionic bond, simple theory of ionic structures; Super ionic materials and structures, alkali ion conductors, β- aluminas, silver ion conductors, copper ion conductors, structural principles for fast Ag^+ & Cu^+ ion conductors, oxygen and halide ion conductors, proton conductors, electronic conductors with ion transport, broad classification of super ionic conductors: polycrystalline/ crystalline, glass/ amorphous, composite, polymeric electrolytes, Mechanism of ion conduction in solid state ionic materials theoretical models. Applications of super ionic solids: sensors and partial pressure gauges, fuel cells, solid state batteries, coulometer-timers, electrochemical capacitors, electro chromic display devices etc.

UNIT IV
Luminescence of solids

Introduction, characteristics of luminescence,Luminescence power, Luminescence spectrum, excitation spectrum, Luminescence Rise and Decay.
Thermo luminescence - models: Jablonski model, Configuration-coordination model, energy band model, thermoluminescence mechanisms, Method of analysis; methods using different rates, half width method, initial rise method, Applications of thermoluminescence in radiation dosimetry and dating.

Mechanoluminescence: Mechanoluminescent materials, Characteristics, mechanisms, theories of Mechanoluminescence, applications.
Lyoluminescence, LL reader, Inorganic lyoluminescence phosphors, mechanisms, enhancements and spectra.

UNIT V
Electro-Optic Materials

Electronic transitions-absorption and excitations, trapping and capture, recombination, radiative and non radiative recombination's, emission spectra, luminescence efficiency, light emitting diodes, LED configuration & performances, Solar radiation & ideal conversion efficiency, p-n junction solar cells, spectral response, I-V characteristics, heterojunction and thin film solar cells.
General mechanisms of photoconductivity processes, life time, photo-sensitivity, capture cross sections; recombination kinetics in absence of trapping; demarcation between trapping levels & recombination levels, effects of trapping.

Recommended Text & Reference Books:

[1] **Introduction to Nanotechnology** by Charles P. Poole Jr. and Frank J. Owens (Willey Inter. Science Pub. 2003).
[2] **Condensed Matter Physics** by Michal P. Marder (Willy Inter. Science Pub., 2000)
[3] **Nanostructures and Nanomaterials- Synthesis properties and Applications** by Guozhong Cao (Empirical College Press World Scientific Pub., 2004).
[4] **Superionic Solids- Principle and applications** by S. Chandra (NH Pub., 1980).
[5] **Superionic Solids and Solid Electrolytes- Recent Trends** by A.L. Laskar & S. Chandra (Eds.) (Academic Press, 1989).
[6] **Physics of Semiconductor devices** by S.M.Sze (Willey Int., 1981).
[7] **Photoconductivity of Solids** by R.H.Bube (Willey Int., 1967).
[8] **Luminescence of Solids:** R Vij (Plenum Press)

PAPER – III ASTRONOMY & ASTROPHYSICS

UNIT – I
Stellar Physics

Time and Coordinate system: Celestial Sphere, Solar Time, Sidereal Time, Julian Date, Right Ascension and Declination, Azimuth and Elevation, Magnitude, Luminosity and Stellar Distances.

A review of formation, structure and evolution of stars, final stages of stellar evolution of stars: white dwarfs, neutron stars and black holes.

Binary stars: close binary systems and their evolution; algols, cataclysmic variables, and x-ray binaries, Supernovae: Types, Characteristics and Energetics, Pulsars: Models and Energetic, Binary pulsars.

UNIT – II
Radiative processes

Synchrotron Radiation: Total emitted power, Spectrum of synchrotron radiation, Spectral index for Power law electron distribution, Spectrum and Polarization of synchrotron radiation, Transition from cyclotron to synchrotron emission, Distinction between received and emitted power, Synchrotron self absorption.

Compton scattering: Thomson scattering, Cross section and Energy transfer, Inverse Compton scattering, power and spectrum from single Compton scattering, multiple Compton scattering**.**

UNIT -III
Inter-Stellar Matter(ISM)

Inter-Stellar Matter (ISM) : an overview of evidence of matter between stars, distribution of dust and gas in the Galaxy, methods of detection of dust and gas.

Interstellar dust: dust extinction and reddening, properties of the dust grains, diffuse interstellar absorption bands. Neutral interstellar gas : atomic interstellar absorption lines, 21cm line of HI, HI clouds, interstellar molecular lines and Molecular clouds. Ionized gas : HII regions, Planetary nebulae, supernova remnants and hot interstellar gas.

UNIT – IV
Surface Photometry of Galaxies

A review of morphological classification of galaxies, surface photometry of galaxies: Isophotes and ellipse fitting procedure, surface brightness profiles and geometrical profiles, color profiles. Photometry of elliptical galaxies: de Vaucouleurs law and other fitting functions and characteristics parameters. Isophote shapes: deviation from elliptical shapes, boxy and disky isophotes, faint features (dust, stellar disk shells etc) in elliptical galaxies. Correlations among global parameters and scaling laws: Faber-Jackson relation, the Fundamental plane and its interpretation.

UNIT – V
Active Galactic Nuclei (AGN)

Taxonomy of AGNs: Seyfert galaxies, Quasars, Radio galaxies, LINERS, BL Lac Objects and OVVs, Narrow line X-ray galaxies.
Black hole paradigm: mass of central object, fueling quasars, accretion disk structure.
Continuum emission: UV-optical continuum, infrared continuum, radio continuum and compact radio sources, superluminal motion.
The broad-line region (BLR): broad-line spectra, basic parameters, photoionizaion of the BLR, line profiles.
The narrow-line region: narrow-line spectra, physical conditions in low density gases, basic parameters, line profiles. Unified models of AGNs.

Recommended Text & Reference Books:

- Astrophysics for Physicists, Arnab Rai Choudhuri, Cambridge University Press, 2010.
- Introductory Astronomy and Astrophysics, M.Zeilik and S.A. Gregory, 4 th edition, Saunders college publishing.
- Theoretical Astrophysics, vols – I, II & III, T. Padmanabhan, Cambridge university press.
- The Physical Universe: An introduction to astronomy, F.Shu, Mill valley: University science books.
- The new cosmos, A.Unsold and B.Baschek, Newyork, Springer Velas.
- Quasars and Active Galactic Nuclei, A.K. Kembhavi and J.V. Narlikar, Cambridge university press.
- Galactic Astronomy: Binney and Merrifield (Princeton Univ Press).
- An introduction of AGN: B M Peterson (CUP).
- The Physics of the ISM: J E Dyson and D A Williams (IOP Publishing)**.**
- Radiative processes in Astrophysics: G B Rybicki and A P Lightman (JOHN WILEY).