RANI DURGAVTI VISHWAVIDYALAYA, JABALPUR
SYLLABUS

M. PHIL IN PHYSICS

(With Effect From the Session 2018-2019)

(In Accordance with the Provisions laid down in the Revised M.PHIL. Ordinance NO. 82)

The duration of the course shall be of two consecutive semesters / one year.

First Semester : The credit of the M.Phil course work (24) credits will be as under

S.No.	Title of Paper	Max. Marks	Min. Passing Marks	Credit
Paper I	Research Methodology, Quantitative Methods and Computer Applications	100	50	4
Paper II	Review of Published Research in the relevant field	100	50	4
Paper III	Computer Application	100	50	4
Paper IV	Advance course in the relevant subject (Any one)	100	50	4
Paper V	**Synopsis Submission**	100	50	4
Paper VI	Comprehensive Viva- Voce	100	50	4

Second Semester

Upon satisfactory competition of course work, the M. Phil scholars shall be required to undertake research work (dissertation/thesis) in the second semester (24 credits). Along with some seminars and presentation as prescribed below :

S.No.	Title of Paper	Max. Marks	Min. Passing Marks	Credit
Paper I	Seminar	100	50	4
Paper II	Term Paper/ Assignment	100	50	4
Paper III	Final Dissertation/ Project Presentation	100	50	12
Paper IV	Comprehensive Viva	100	50	4

The candidate has to obtain a minimum of 55% of marks or its equivalent grade point in aggregate in the course work in order to be eligible to continue in the M. Phil programe and submit the dissertation / thesis. The candidate has to obtain a minimum of 55% of marks or equivalent grade point in aggregate in the second semester as well.

A candidate shall be declared to have successfully completed the course; if/she obtains minimum 50% passing marks or equivalent grade (c) in all the papers separately.

If a student obtains F or Ab grade in a paper/ subject, he/she will be treated to have failed in that paper. He/she have to reappear in the examination of that subject/ paper as and when conducted or arranged by the UTD in next semester. If the students fails in aggregate

then he/she can opt upto, maximum of any two papers to reappear in the examination.Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat end semester examination to decide the grade in the repeat course. No students shall be allowed to repeat the course to improve the grade if he/she pass the course. further fail in the course, he/she shall not be given another chance and he/she shall be out of the M.Phil programme.

FIRST SEMESTER

PAPER – I **100 Marks; 4 Credits**

Research Methodology, Quantitative methods and Experimental Techniques

UNIT – I

Research Methods and Design: Nature and objectives of research, Methods of research: historical, descriptive and experimental research process. Research Approaches and types of research. Research and the scientific Methods, Criteria of good research, Defining the research problem.

Research Design: Meaning and need for research design. Features of good design, Different research designs. Basic principles of experimental design. Limitations of experimentation.

UNIT – II

Quantitative Methods: Nature and purpose of mathematical statistics. Experimental and collection of data. Tabulation and statistical inference, analysis of the solution and its Physical significance. Tabular and graphical representation of data. Bar and Pi diagrams, Relative frequencies, sample mean and sample variance. Random experiments, outcomes and events. Probability distribution (Binomial, Poission and Normal). Random sampling. Introduction to random and pseudo random numbers random number generators. Estimation of parameters, confidence intervals. Testing of hypothesis and decisions. types of errors, goodness of fit χ^2 –test, method of least squares, fitting straight lines and polynomials. Data analysis using Fourier techniques. Idea of convolution and deconvolution.

UNIT-III

Quantitative Methods-II: Solution of coupled differential equation by Runge Kutta methods. Application to solution of Schrödinger equation for one dimensional box, one dimensional potential barrier and one dimensional harmonic oscillator. Solution of partial differential equation by the lattice method. Application to the solution of laplace equations(using BASIC).

General idea of mathematical modeling and simulations. Monte Carlo technique. Simulation of radioactive decay and random walk problem (using BASIC).

UNIT-IV

Experimental Techniques-I: General ideas of preparation of crystalline, nanocrystalline, and polymeric materials with grain size in micron as well as nanometer region-crystal Pulling method, solid state reaction method, wet chemical method, sol-gel method, rapid quenching method, r.f.

induction method, r.f. sputtering method, mechanical grinding, and size control by capping agent, molecular beam epitaxy, electro-deposition method, gas consolidation method. Idea for measurement of thickness of thin film.

UNIT-V

Experimental techniques-II: General idea of characterization of crystalline, noncrystalline and polymeric materials using Optical Absorption and Emission, Interferometry, Mechanical Testing,TSDC, XRD, SEM, DSC, IR, NMR, AFM, Impedance spectroscopy, General idea of observing space data and its applications, Extracting scientific information from space data, General idea of types of noise in experiments and methods of minimization.

Reference Books :

1. Research Methodology – Method and Techniques – C.R. Kothari, New Age International Publisher, New Delhi – 2004.
2. Research Principles, Application and Laser – D.D. Sharma, S. Chand & Sons. Publisher.
3. Computational Physics – An Introduction – R.C. Verma, P.K. Ahluwalia & K.C. Sharma New Age International Publisher, New Delhi – 1999.
4. Advanced Engineering Mathematics – E. Kreyszig, Wiley Eastern Ltd.
5. Experimental Methods in Modern A.C. Mellissions, A.P. New York, London.
6. Instrumental Methods of Analysis – Willard
7. Thin Films – K.L. Chopra
8. Nanotechnology : Principle and practices – S.K. Kulkarni
9. Semi conductor Measurement – Runyan

PAPER-II **100 Marks; 4 Credits**

REVIEW OF PUBLISHED RESEARCH IN THE RELEVANT FIELD

This includes report writing evaluation and presentation/Viva Voce each of 50 marks

PAPER-III **100 Marks; 4 Credits**

COMPUTER APPLICATION

UNIT-I

Concept of Computer Architecture : General Idea of Microprocessor types and specifications, Processor sockets and slots, Concept of computer interface, chip set, motherboard, Concept of bus systems and types, Memories : SRAM, DRAM, FRAM, EDORAM, SIMM, DIMM, DDR, Serial and Parallel communication ports : standard, use and configuration, USB, RS232, IEEE 488 interface.

UNIT-II

Introduction to UNIX/Linex operating system : Command cells, special character, command path and syntax, Directory layout, Commands for files systems and finding things, Pipe lining and re-direction, Information commands and other utilities, Concepts of PYTHON with simple examples.

UNIT-III

Advanced concept of Mathematica : Commands and variables, Symbolic computations with example, Manipulation of matrix, Plot of data and function, Use of import and export commands, Reading of data with special examples.

UNIT-IV

Introduction to Multisim Software : Commands, Wiring the schematic, Simulating the circuit, Transferring to PCB layout, Introduction to LAB VIEW : Environment basics, graphical programming, Basic commands and debugging tools, Introduction of exp EYES with computer control data acquisition system.

UNIT-V

1. Writing a program in BASIC for single Numerical Integration of a function by Trapezoidal rule and Gaussian quadrature. Verification by MATHEMATICA/MATLAB /SCILAB.
2. Writing a programme in BASIC for plotting a function. Verification by MATHEMATICA/MATLAB /SCILAB.
3. Writing a programme in BASIC for Fourier Analysis/ Fourier synthesis of periodic signals Verification by MATHEMATICA/MATLAB /SCILAB.
4. Study the behavior of RC circuits using exp EYES.
5. Development of programme to read data in a .DAT file and calculate value of micro hardness and creates plots of micro hardness vs load using EXCEL.
6. Writing a programme in BASIC for least square fitting of data to a state line. Verification by MATHEMATICA/MATLAB /SCILAB.
7. PYTHON code to solve simple Physics problem and creating icon.
8. Design of simple electronic circuit and its simulation using multisim.

References:

1. Computer System Architecture, Moris Mano, Third Edition, Pearson Education
2. IBM PC and Clones : Govindraju, McGraw Hill Education
3. The Complete PC upgrade Guide, Mark Minasi,16th Edition, Joel Fugazotto
4. Complete guide to upgrading and repairing PC : Petter Nortorn, 2nd Edition, Sams
5. Introduction to LINUX command : Victor Gedris.
6. Manual of Mathematica
7. Manual of Multisim by National Instruments
8. Manual of LAB View by National Instruments
9. e-Manual of exp EYES
10. Numerical Methods for Scientific and Engineering Computations : M.K. Jain, S.R. K. Iyenger and R.K. Jain, 3rd Edition, New Age International (P) Ltd
11. Numerical Mathematical Analysis- James B. Scharborough, Oxford & IBH
12. Numerical Methods, E. Balaguruswamy Tata McGraw Hill
13. Computational Physics, K.C. Sharma, P.K. Ahluwalia, R.C. Verma, New Age International (P) Ltd

PAPER-IV **100 Marks; 4 Credits**

ADVANCE COURSE IN THE RELEVANT SUBJECT (ANY ONE)

IV (a) : SURFACE STRUCTURE AND MECHANICAL PROPERTIES OF MATERIALS

UNIT – I

Vapour- Solid process, Liquid- Solid process- Bridgman, Czochralski, Kyropoulos, Stockbarger Techniques; Solid- Solid process, Zone refining. Defect formation by quenching, irradiation, alloying and plastic deformation. Methods of preparation of thin films, Pellets, flakes, blends and alloys. Study of vacuum coating unit, Impedance analyzer and Rio meter.

UNIT – II

Theory of etching, effect of impurities in enchant, reliability of an etching method, etch pits morphology, origin and multiplication of dislocations in crystals under stress, characteristic dislocation in bcc, fcc and **hop** crystals, study of surface distortion of single crystals by surface micro morphology and micro- surface topography.

UNIT – III

Tensile testing of brittle and ductile materials, plastic stretching of single crystals, type of fracture in tension, strength theories, Impact test; Mechanical behavior of crystalline solids at elevated temperature: Creep, Factors affecting creep rate, Design for creep, high temperature service, stress relaxation; Mechanical hysteretic, Endurance test, corrosion fatigue, causes of fatigue, Effect of Irradiation on mechanical properties of materials.

UNIT – IV

Concept of Hardness, Micro hardness and Nano. Testing methods Hardness testing, Brinell and Rockwell hardness tester, Micro-hardness testing, Knoop and Vickers hardness testers, Nano hardness. Variation of hardness with Load, logar ithmic index number n, testing and application of micro- and nano indentation, Nano indentation & AFM to study of metallic non- metallic and polymeric material.

NOTE: Eight questions should be set in all, out of which Two questions will be from each section. The students will have to solve one question from each unit.

IV (b) : POLYMER PHYSICS

UNIT – I

The chemical structure of Polymers, Internal rotation, conformation, configuration and molecular packing, Bonding and molecular geometry, Flexibility of macromolecules.

Aspects of molecular characterization in polymers, Molecular weight and its distribution, crystalline structure, Morphology and crystallization of polymers, properties of polymer melts.

UNIT – II

The physical states of Polymers, the glass transition temperature, structural and thermodynamic properties of polymers, viscoelastic properties of polymers, Mechanical properties and strength of polymers. Role of additive on polymers, Elastomers, Thermoplastics, Fibres,

Thermosets, polymer alloys and their mechanical properties, Kevlar fibres, Diffustion and transport properties of polymers, polymer liquid crystals, Recent technology of advanced composites: Problems and promises.

UNIT – III

General theory of dielectric relaxation, cooperative dipolar relaxation in polymers, single and multiple dielectric dielectric relaxation processes in solid polymers, temperature dependence of dielectric properties; dielectric properties and structure, Network amorphous polymers, plasticised polymers.

Polarisation mechanism in polymers, dipolar and space charge polarization in polymer electrets, isothermal and thermally stimulated depolaristation processes in electrets, measuremtns of dielectric properties by bridge resonance and wave-guide methods.

UNIT – IV

Electrical Transport in crystalline and Non crystalline Materials: Thermally stimulated current (TSC). Traps in semiconductors (general equations, fast- retrapping analysis, and general analysis) , Steady state injection currents in insulators with shallow and deep traps; carrier emission from neutral traps under electric field (Poole – Frankel conduction). Ionic and electronic conduction; steady state space charge limited trap free and trap controlled conduction, Rechardson – Schottky mechanisms of charge transport, Tunneling and hopping models for charge transport.

Electret micropone, Electret transducers, Electret filters, Electret motors and biological applications of electrets.

Note;- Eight questions should be set in all, out of which Two Questions will be from each section. The students will have to solve one question from each unit.

References

1. Electrical Properties of Polymers A.R. Bly the – Cambridge University Press, London.
2. Electrets G.M. Sessler springer Verlag
3. Physical chemistry of polymers, A. Tager, Mir Publisshers
4. Electrical conduction and Breakdown in solids dielectrics , J.J. O'Dwyer; Clarendon Press, Oxford.
5. Dielectric Material and Applications, A.R. Von Hipplel (Ed); Techn. Press MIT and Wiley, New York.

IV (C) – PHYSICS OF OPTO ELECTRONIC MATERIALS

UNIT – I

Photoconductivity; General mechanism of photoconductivity, linear and quadratic recombination, Demarcation between trapping levels and recombination levels; Effect of trapping Sensitization by impurity incorporation. Preparation of photoconductors.

Photo detectors: Vacuum photodiodes, photo multipliers, image intensifiers, photoconductive detectors, Photodiodes and phototransistors.

UNIT – II

Luminescence: Configuration co-ordinate curve model and energy band model rise and decay of luminescence, preparation of ZnS and ZnSe phosphors, Thermoluminescence, Different methods of determining trap-depth from thermoluminescence glow curve, Electroluminescence acceleration collision mechanism of electroluminescence, organic electroluminescence devices, Cathodoluminescence television phosphors, Mechanoluminescence and its experimental measurement, mechanism and master equation of mechanoluminescence, Elementary idea about the photoluminescence of semiconductor Nanocrystals.

UNIT – III

Light Emitting Diodes, spectrum of recombination radiation, internal quantum efficiency, behavior at high frequency, double heterostructures; useful properties and modulation band width, fabrication of heterostructures, External quantum efficiency , LEDs designs-

Semiconductor lasers, Features of laser radiations, theory of laser action in semiconductors, gain co-efficient, threshold current density differential quantum efficiency,quantum well and quantum dot lasers.

UNIT – IV

Solar cells: Photovoltaic effect, Total photocurrent generation in p-n structure solar cells, charaterization and solar cells parameters, solar cell materials- silicon , Amorphous silicon, Gallium Arsenide Cds-Cu2-S photoelectrochemnical and photo electrolysis solar cells, polymer solar cells, Nanostructured solar cells, solar cell, fabrication technology, photovoltaic modules, solar cells array, storage of solar energy and application of solar cells.

References :-

1. Photoconductivity	:	Bube
2. Opto electronics	:	Wilson & Hahkes
3. Luminescence in crystal	:	Curie
4. Optical communication System	:	John Gower
5.Esscntial of solar cells	:	Kotnala & Singh
6. Semiconductor opto electronics devices	:	P. Bhattacharya

IV (d) ELECTRONIC INSTRUMENTATION

UNIT – I

General purpose Instruments, commonly used in the Electronics Laboratory:

Regulated power Supply – Transistorized, IC Voltage Regulator 723, parameters of regulated power supply- Load Regulation, line Regulation Ripple factor; Short circuit protection in regulated power supply; few three pin voltage regulators- LM 317,7800 and 7900 series of 3 pin IC voltage regulators. Cathode Ray oscilloscope (CRO) - block diagram, principle of working, Audio Frequency R-C oscillators, wein Bridge oscillator; Sweep circuits; Analog multimeters.

UNIT - II

Applied Instrumentation: Analog versus Digital Instrumentation operational Amplifiers and their use in Instrumentation, Transducers, Signal conditioning, Voltage comparators using Op-amp, Window Detectors, Voltage to Frequency and Frequency to Voltage Converters, Log and Antilog Amplifiers, Multipliers and Dividers, Differential Amplifier, Sample and Hold circuits, Frequency doubling.

UNIT – III

Digital Instrumentation:

Digital Comparators, D/A and D/A Converters, Digital Display Systems Nixic tube, 7 – segment, Dot Matrix Types; Decoders and Drivers for Display Devices, Multiplexing Displays, Digital Frequency and Time period counters, Event counters, Digital Voltmeter, DMM.

UNIT – IV

Microprocessors Based Instrumentation:

Microprocessors Based Electronic test and measuring instruments – basic principles; Design of Microprocessor based signal generator, frequency meters.

Microprocessor based temperature measurement and control systems; data acquisition systems.

Note;- Eight questions should be set in all, out of which Two Questions will be from each section. The students will have to solve one question from each unit.

IV (e) : COSMIC RAYS AND SPACE PHYSICS

UNIT – I

Properties of cosmic ray : Nature, composition, charge and energy spectra of primary cosmic ray; propagation of cosmic rays through Earth's atmosphere, secondary cosmic ray particles in the atmosphere and at ground; theories of the origin of primary cosmic rays and its propagation through intervening medium.

UNIT – II

Cosmic ray detectors: Construction and working- LGY type standard Neutron Monitor and NM – 64 type Super Neutron Monitor, Meson Telescope, Extensive Air Shower Detector, Emulsion and plastic detectors.

UNIT – III

Modulation of cosmic rays : Spatial anisotropies and the daily variation of cosmic rays, long and short term anisotropic modulation; the 11- year and long term modulation of cosmic rays, Forbush decrease and 27- day modulation; the variational characteristics and simple explanations to these modulations of cosmic rays.

UNIT – IV

The Sun and Solar System physical characteristics of the Sun, Solar photosphere chromospheres and the corona; idea of solar activity, sun spots and its variation, solar flares,

the solar wind, interplanetary plasma and magnetic fields, interaction of solar wind with geom. genetic field, physical characteristics of planets.

Note;- Eight questions should be set in all, out of which Two Questions will be from each section. The students will have to solve one question from each unit.

IV (F) PHYSICS OF NANOSTRUCTURES

UNIT –I

Definition and importance of nanostructured materials, Emergence of nanotechnology, Reasons of size dependence of properties Bottom up and top-down approaches. Classification of nanostructure materials, Porous nanostructures.

Concept of quantum confinement, Idea of quantum well, quantum wire and quantum dots. Electronic structure and density of states in 3D, 2D, 1D and 0D structures with examples.

UNIT – II

Preparation of nanstructures Preparation of Nanoparticles through homogenous nucleation, preparation of Nanoparticles through heterogeneous nucleation, Kinetically confined synthesis of nanoparticles, Epitaxial growth core-shell nanoparticles.

Preparation of nanowires and nanorods : Spontaneous growth, Template based synthesis, Electro spinning, Lithography.

Preparation of thin layers : Fundamentals of film growth, Physical vapor deposition, Chemical vapor deposition, Langmuir – Blodgett films, Sol-Gel films. Atomic layer deposition, Electrochemical deposition.

UNIT – III

Characterization and Properties of Nanomaterials

X-ray diffraction (XRD), Atomic force microscopy (AFM), Transmission And scanning Electron microscopy (TEM), Optical spectroscopy.

Physical properties : melting points mechanical properties, optical properties, absorption luminescence surface Plasmon responance.

Electrical conductivity , surface scattering , change of electronic structure, quantum transport .

Ferroelectrics and dielectrics, superparamanagnetism.

UNIT – IV

Special Nanomaterial and Nanodevices

Carbon fullerenes and nanotubes, Micro- and Mesoporous materials, Core shell structures, nanograined structures, polymer nanocrystals and nanocomposites, supramolecular structures, Biological nanostructures.

Effect of bulk nanostructuring on magnetic properties. Dynamics of nanomagnets, Giant and Colossal magnetoresistance, Ferrofluids.

Nanoelectronics, Bandgap engineered quantum devices, Nanomechanics, Photonic crystals.

Note;- Eight questions should be set in all, out of which Two Questions will be from each section. The students will have to solve one question from each unit.

References.

1. Nanostructures and Nanomaterials, G. Cao Imperial College Press (2003).
2. Introduction to Nanotechnology, C.P. Poole Jr. and F.J. Owens, Wiley India (2007).
3. Nanotechnology : Principles and Practices, S.K. Kulkarni, Capital Publ. Co., N. Delhi (2007).

PAPER V **100 Marks (4 credits)**

Synopsis Submission

(Synopsis preparation/ write-up and presentation/ Viva-Voce each of 50 marks)

PAPER VI **100 Marks (4 credits)**

COMPREHENSIVE VIVA VOCE

Second Semester

PAPER I **100 Marks (4 credits)**

SEMINAR

(Two seminar each of 50 marks)

PAPER II **100 Marks (4 credits)**

TERM PAPER/ ASSIGNMENT

PAPER III **100 Marks (12 credits)**

FINAL DISSERTATION/ PROJECT PRESENTATION

PAPER IV **100 Marks (4 credits)**

COMPREHENSIVE VIVA-VOCE