INDEX

SEMESTER SYSTEM OF P. G. PHYSICS

P. G. SEMESTER EXAMINATION REGULATIONS

CHAPTER – I

REGULATION OF GENERAL ACADEMIC MATTERS

1.1 The Departments shall follow Semester System of teaching and Examination based on continuous evaluation internally as well as externally subject to moderation of question papers. The system of evaluations of the students shall be based on Course Credit System.

1.1.1 Academic Year

The Academic Year of the department shall ordinarily be from JUNE to MAY. It may however, be modified by the Staff Council from time to time.

1.1.2 Semester

The academic year shall have two semesters, each of which shall be of 6 months duration.

1.2 Minimum working days in a Semester

A Semester shall have a minimum of 90 working/instructional days excluding examination days/Sundays/Holidays etc. The minimum number of classes in a semester shall not fall short of the number of classes as mentioned below.

1. One Credit hour courses = 10 classes minimum
2. Two Credit hour courses = 20 classes minimum
3. Three Credit hour courses = 30 classes minimum
4. Four Credit hour courses = 40 classes minimum
5. Five Credit hour courses = 50 classes minimum

1.3 ***Credit hours***

One credit shall signify the quantum of teaching imparted corresponding to one hour of theory class and two hours of laboratory/project work and two hours of seminar per week during a semester in respect of a particular course. Each teaching hour of theory class will be of 60 minutes and practical classes/project work will be of 120 minutes duration and seminar will be of 120 minutes duration. For field study outside headquarters, one working day will be considered as two teaching hours. However, the field study should not exceed 30 days (including Sundays) in one semester.

The P. G. Syllabus may be so designed that the total of credit hours for all four semesters shall be 80 spread equally over all semesters as far as practicable, tutorials and proctorials shall be treated as non-credit components.

1.4 ***Course***

A course is a Unit of instruction under any discipline carrying a specific number of credit hours describing its weightage. Those courses, which a student must take as compulsory requirement, are, called Core Courses. Those courses, which a student opts out of a list of specialized courses offered by the department, are called Elective Courses.

Choice Based Credit System (CBCS) is introduced at the P. G. Semester-I level uniformly in all the subjects to be taught in paper-103. The students of P. G. Arts stream can not opt for the CBCS course of Science stream. The details of the CBCS courses offered by different P. G. Departments are given in Annexure-II.

ANNEXURE-II

CBCS: P. G. Paper-103

Department	Name of the CBCS Course
Botany	Plant in Human Welfare
Chemistry	Polymer Science
Commerce	Fundamental of Business Organization and Entrepreneurship Development
Economics	Indian Economy
Education	Pedagogical Trends and Issue
English	Global English
Geography	Introduction to Geography
History	Tourism & Heritage Management
Mathematics	Elements of Computer Programming
Odia	"Adhunika Odia Nataka o Odia Bhashara Dhwanitatwa" (Modern Odia Drama and Odia Phonetics)
Physics	Foundation in Physics
Philosophy	Practical Ethics
Political Science	Indian Government & Politics
Psychology	Fundamentals of Psychology
Sanskrit	Ancient Indian Culture
Zoology	Animal World, Human Health & Economic Zoology

1.4.1 ***Grade***

The grade awarded to a student in any particular course shall be based on his/her performance in all the tests conducted during a semester and shall be awarded at the end of the semester. The grade in each course is expressed in numerical value in 10.00 scale. The marks of a student shall be converted to10.00 scale and the points scored thereby shall be called the "Grade Point" in the course. Respective "Grade Point Average" (GPA) and "Overall Grade Point Average" (OGPA) shall be awarded at the end of each semester and all semester respectively. A 3.0 Grade Point is required for passing in individual paper and 4.0 GPA to pass any semester examination. The G. P. shall be rounded to one decimal point and GPA to two decimal points.

1.4.2 Grade Point Average (G.P.A.)

Grade Point Average (G.P.A.) of a semester shall be calculated as:

$$\text{GPA} = \frac{\text{Summation of } \{(\text{Credits in each course}) \times (\text{Grade point in that course})\}}{\text{Total No. of Credits in that Semester}}$$

Where the summation is taken over all courses in a given semester, G.P.A. shall be rounded up to 2 decimal points.

1.4.3 O.G.P.A. (Overall Grade Point Average)

It is the average of accumulated grade points of a student, worked out by dividing the cumulative total of grade points by the cumulative total of credit hours of all the courses covered and completed by a student during all the Semesters. For the first semester of the programme the GPA and OGPA shall be the same.

$$\text{OGPA} = \frac{\text{Summation of } \{(\text{Credits in each semester}) \times (\text{Total Credits in that semester})\}}{\text{Total No. of Credits in that Semester}}$$

Where the summation is taken over all semesters in a given programme. OGPA shall be rounded up to e decimal points. For merit lists, in case of equality, the OGPA shall be calculated beyond two decimal places if necessary.

1.4.4 Conversion of grades to marks and classification of results under course credit system

The OGPA can be converted to percentage of marks in the following manner:

Percentage of Marks = (OGPA) ×10

A student after successful completion of all the semesters, Degree shall be awarded in the following manner:

O.G.P.A. ≥ 6.0 : FIRST CLASS
O.G.P.A. ≥ 5.0 - < 6.0 : SECOND CLASS
O.G.P.A. 4.0 - < 5.0 : THIRD CLASS
O.G.P.A. < 4.0 : FAIL

1.5 ***Academic Calendar***

The Examination Section and the academic section shall finalise the schedule of semester registration and other academic activities at the start of academic session. The Academic Calendar shall be prepared by the Academic Committee of the University in consultation with examination section.

The broad format for academic calendar for P. G. with regard to admission, registration and commencement of classes shall be as follows:

Admission and Registration and Commencement of Classes for 1st Semester	JULY
1st Semester Examination	DECEMBER
Commencement of Classes 2nd Semester	JANUARY-MAY
2nd Semester Examination	JUNE
Commencement of 3rd Semester Classes	JULY-NOVEMBER
3rd Semester Examination	DECEMBER
Commencement of 4th Semester Classes	JANUARY-APRIL
4th Semester Examination	APRIL & MAY
Final Results to be published in the month of	JUNE

1.5.1 Requirement of award of degree

The minimum credit hour requirement for the Master Degree shall be 80 (eighty) credits and the residence required for Master Degree shall be continuous four semesters from the first date of registration and the maximum time allowed to complete the Master Degree shall be 8 (eight) semesters.

1.6 Requirement for attendance

A candidate shall be required to attend 75% lectures, tutorials and practical classes separately during the semester (For late admitted students' attendance to be calculated from the date of admission). Condonation may be granted by the staff council only to the extent of 15% in exceptional cases. (Illness, accident, mishap in the family, deputation by University/Department). When a candidate has been deputed by the University to represent the University/state for any activity, the lectures delivered during his/her absence for the purpose shall not be counted towards the calculation of attendance provided the student submits a certificate to that effect from the appropriate authority.

1.7 ***Registration in a semester***

A student has to register his/her name at the beginning of every semester in the prescribed form, for the course he/she wants to take in that semester. Examination Section (General) shall notify the registration dates and the list of registered students for the semester shall be given to the Head of the Department within two weeks of the commencement of the Semester.

CHAPTER – II
REGULATIONS ON EXAMINATION MATTERS

2.1 Mid Term Examination

In each Semester there shall be one Mid Term Assessment examination of 60 minutes duration. The Mid Term examination shall be conducted by COE like that of End Term examination. The answer scripts shall be evaluated by the external and internal examiners and the marks along with answer scripts shall be retained in COE.

2.2 Semester Examination

After the end of each semester there shall be an examination of each theory paper of 2 hours duration and of each practical paper of 4 hours duration, which shall be called Term End / "Semester Examination". The maximum marks for each theory paper shall be 50 out of which 40 marks for term end and 10 marks for Mid Term. The maximum marks for each practical/ semester/ project/ dissertation/ review examination shall be 50 for Arts and Commerce and 100 marks for Science. The classes shall remain suspended ten days (including Sundays and holidays, if any) before the date of commencement of semester test for preparation by the students.

2.3 Results of Examinations

The results shall be declared ordinarily within four weeks of completion of the examinations. A students who seeks re-addition of his/her marks in a course shall be allowed to do so by submitting an application to Registrar along with a required fees in the fee counter of the University. All such cases/complaints if any shall be disposed of by the Examination Section in a prefixed day and necessary corrections if any shall be reflected in the mark/grade sheet. The candidates shall have to appear in all the Units of a semester examination to be eligible to be a declared 'pass' provided he/she secures minimum pass marks/grade.

2.4 Promotion to the next semester

A student shall be admitted to the next semester only when he/she appears in all the papers of the concerned semester examination. However, a student failing to appear semester examination in some or of all papers due to some reasons as mentioned in 2.5 may be admitted to the next semester. Such a student shall produce sufficient proof in favour of his/her reason for not being able to appear in some or all papers of the Semester Examination on the next academic session in the corresponding semesters.

2.5 ***Absence from Examination***

If a student is unable to appear a semester examination in some or all papers the Registrar shall consider his/her case for admission into the next higher semester only the following cases:

(a) When he/she is hospitalized.

(b) When he/she is not be able to appear in the examination due to serious illness or death of parents, brothers, sisters, spouse or children.

(c) When he/she met an accident of serious nature.

(d) When the department/University or any official directive deputes him/her

2.6 ***Procedure for Repeat/Improvement***

A student who wants to sit for the semester examination of first and/or second semester in the subsequent academic session (for repeat or improvement) he/she shall have to apply to the Registrar in plain paper before fifteen days of the commencement of the said examination. If allowed by the Registrar, he/she shall deposit the required fees for each paper with centre charge and produce the proof to the teacher in-charge examination with permission letter from the Registrar.

In a semester to appear improvement examination the candidates must have passed the semester examination. A candidate can appear repeat examination of papers in which he/she has failed or not appeared for reasons mentioned in 2.5.

The Master Degree student seeking to appear/improvement examination in any course(s) shall get 3 chances for 1st and 2nd semester within 8 semesters.
Candidates appearing in repeat/improvement examination shall not be considered in the merit list and it shall be reflected in the Provisional Certificate cum Mark sheet (PCM) but not in the final degree certificate.

2.7 Award of Degree Certificate, Grade/Mark sheet

A Degree certificate under the official seal of the university and signed by the Vice-Chancellor shall be presented at the Convocation or in absentia to each of the successful students of particular degree. The Controller of Examinations shall issue the mark/grade sheet of each semester to the candidates in the sheet of each semester to the candidates in the prescribed format by depositing the required fees for marks/Grade Sheet to be deposited in the University counter.

2.8 **Guideline for filling up of Forms for PG Classes (IMP/ Repeat)**

A student shall repeat all the theory and practical papers in which he/she failed in the semester examination within a period of eight semesters from the date of first registration. Such students shall have to apply to the Head of the Department/Registrar in plain paper during the filling up of form for the ensuing semester examination. If allowed, he/she shall deposit the fees as prescribed by the University

If a candidate secures less than 3.0 Grade point in a paper(s) and less than 4.0 Grade point average in a Semester examination he/she has to appear all the papers in that Semester.

If a candidate secures less than 3.0 Grade Point in a paper(s) and a minimum 4.0 Grade point average in a semester examination, he/she has to appear only the paper(s) in which he/she secured less than 3.0 Grade point.

A candidate is eligible to sit for improvement in a paper(s) only when he/she has passed the semester examination concerned. Further, he/she can improve in a maximum of EIGHT paper(s) in the entire course. The Master Degree students seeking to take improvement examination in any course(s) shall get chances within 8 semesters from the year of admission to the course. The candidates taking this advantage (improvement) will be examined on the basis of current syllabus and the higher marks shall be retained during computation of result.

2.9 If a candidate fails to appear in any paper of the said examination and marked ABSENT his/her results will be declared only when he/she clears that paper/those papers.

2.10 ***Disciplines in the Examination***

(A)Late Comers: A student arriving in the examination hall/room fifteen minutes after the commencement of the examination shall not be ordinarily allowed to sit for the examination. No examinee shall be allowed to go out of the examination hall within one hour of commencement of examination. The invigilators shall keep a record of temporary absence of students from the examination hall/room during the examination.

(B) Adoption of unfair means in the Examination:
Possession of unauthorized materials and using it, copying from scripts of other students or from any other source, showing his/her answer script to others during the examination, creating disturbance or acting in a manner so as to cause inconvenience to other students in the examination hall or near about shall be treated as adoption of unfair means or malpractice.

Sd/-
REGISTRAR

P. G. COURSE OF THE DEPARTMENT OF PHYSICS AT A GLANCE

(Under Course Credit System) **Total 250** **20 CH**

Course No.	Name of the Course	Marks	Credit
	FIRST SEMESTER		
PHY-101	Classical Mechanics	50 (40+10)	5 CH
PHY-102	Mathematical Physics & Comp. Programming	50 (40+10)	5 CH
PHY-103	Foundation in Physics: CBCS course	50 (40+10)	5 CH
PHY-104	Practical: (A) Experiments of Optics	100	5 CH
		250	**20**
	SECOND SEMESTER		
PHY-201	Quantum Mechanics (I)	50 (40+10)	5 CH
PHY-202	Nuclear and Particle Physics	50 (40+10)	5 CH
PHY-203	Electrodynamics	50 (40+10)	5 CH
PHY-204	Practical: (A) Experiments on Electricity (B) Experiments on Basic Electronics	100	5 CH
		250	**20**
	THIRD SEMESTER		
PHY-301	Quantum Mechanics (II)	50 (40+10)	5 CH
PHY-302	Solid State Physics	50 (40+10)	5 CH
PHY-303	Electronics or Advanced Optics & Spectroscopy	50 (40+10)	5 CH
PHY-304	Practical : (A) Experiments on Modern Physics (B) Experiments in Computer Laboratory	100	5 CH
		250	**20**
	FOURTH SEMESTER		
PHY- 401	Statistical Mechanics	50 (40+10)	5 CH
PHY-402	Electronics or Advanced Optics & Spectroscopy (Special Paper –II)	50 (40+10)	5 CH
PHY-403	Electronics or Advanced Optics & Spectroscopy (Special Paper – III)	50 (40+10)	5 CH
PHY-404	Practical: (A) Experiments on Special Paper (B) Experiments on Special Paper Project/Dissertation	100	5 CH
		250	**20**
		1000	**80**

FIRST SEMESTER

PHY 101: CLASSICAL MECHANICS

Full Mark 50 (10 Mid Term + 40 End Term)

UNIT - I: Rigid Body Motion

The independent coordinates of a rigid body: orthogonal transformation: Euler's theorem on the motion of a rigid body: infinitesimal rotations: rate of change of vector: the Coriolis force.
Angular momentum and kinetic energy of motion about a point (the inertia tensor and the moment of inertia): the principal axis transformation: torque free motion of a rigid body, the heavy symmetrical top with one point fixed.

UNIT - II: Hamiltonian Formulation

Legendre's transformations and Hamilton equations of motion: physical significance of Hamiltonian: derivation of Hamilton's equations from variational principles.

Hamilton - Jacobi Theory: Hamilton - Jacobi equation and its application to harmonic oscillator; action angle variables: the Kepler's problem: Hamilton - Jacobi theory; geometrical optics and wave mechanics.

UNIT - III: Canonical Transformations: The equations of canonical transformation: integral invariant of Poincare: Lagrange and Poisson's brackets as canonical invariant: the equation of motion in the Poisson bracket formulation: infinitesimal contact transformation and conservation theorems.

Small Oscillation: Formulation of the problem of small oscillation: normal coordinates: free vibrations of a linear tri-atomic molecule.

PHY 102: MATHEMATICAL PHYSICS AND COMPUTER PROGRAMMING

Full Mark 50 (10 Mid Term + 40 End Term)

UNIT - I: Special function : Hyper geometric and confluent hyper-geometric equations ; their solutions, generating function, recurrence relations, solutions of inhomogeneous partial differential equation by Green's function method.

UNIT - II: Tensors & Group Theory

Tensors: Cartesian tensors in three dimensional space: curves in three and frenet formula; general tensor analysis.

Group Theory: Definition of Groups: finite groups: examples from solid state physics;
subgroups and classes: group representations; characters: infinite groups and lie groups: elementary ideas about SU (2), SU (3), and O (3).

UNIT - III: Programming in FORTRAN: FORTRAN constants and variables: arithmetic expression and statements: format specification: read & write statements control statements - go to, arithmetic and logical if, if - then - else, nested if - then - else statements: do loops, one and multidimensional arrays and subscripted variables: function and subroutine subprograms: use of common statement: writing simple FORTRAN program.

PHY 103: FOUNDATION IN PHYSICS: CBCS COURSE

Full Mark 50 (10 Mid Term + 40 End Term)

Elementary ideas about the following topics be covered without any cumbersome derivation/ mathematics.

Unit - I: Mechanics & Properties of Matter

(a) Newton's laws of motion, Impulse, Work, Energy and Power. Universal law of gravitation, Kepler's laws, Geostationary satellites, Torque, Centre of gravity, Liquid pressure, Atmospheric pressure, Barometer, Elasticity, Bernoulli's theorem and its applications.

(b) Thermal Physics: Thermal expansion, Transmission of heat, Change of state, Melting point, Boiling point, Effect of pressure on melting point and boiling point, Carnot engine, Refrigeration, Air conditioning.

(c) Wave Motion: Electromagnetic waves and sound waves, Progressive wave, Stationary wave, Transverse vibration of string, Echo, Resonance, Doppler effect, Musical scale, Musical instruments, Intensity of sound, Ultrasonic waves, SONAR, Acoustics of buildings, Total internal reflection, Dispersion, Color of objects, Eye & defects of vision, Optical instruments, Telescope & Microscopes, Scattering of light, Blue color of sky, Interference of light, Elementary idea about diffraction of light and sound.

Unit - II: Electromagnetism, Nuclear Physics and Electronics

(a) Kirchoff's laws, Effects of electric current, Power generation and transmission, Electric energy consumption unit, Transformer, Metals used as fuse wire, Distribution board and distribution fuse board, Series and parallel connections, Earth's magnetism, Magnetic Resonance Imaging (MRI).

(b) Atomic and Nuclear Physics: Atomic structure, Emission of radiation, Radioactivity, Nuclear fission & fusion, Chain reaction, Nuclear reactors, Atom bomb, Hydrogen bomb.

(c) Electronics & electronic measuring instruments, Semiconductors, N & P type semiconductor, p-n junction diode, Transistors and their applications, Photodiode, Photo transistor, Cathode ray oscilloscope and its applications.

Unit - III: Information Technology, Space Science and Energy for Future

(a) AM, FM radio transmitters and receivers, Radio wave propagation, Principles of TV, TV camera, Color TV, Radar and its application. Microwave satellite communication, Optical fiber communication, Principle and applications of LASERS & LEDS, Modern computer communication, Satellite Launching Vehicle (SLV), Rocket fuel, INSAT, Principle of rocket propulsion.

(b) Classification of computers, Organization of computer components, CPU (Primary storage section, Arithmetic and logic unit, Control unit), Standard input devices (Key board, Pointing device, Mouse, Joystick, Tracker ball), Scanner, Standard output devices, Video display unit, Printer, Plotter, Floppy diskette, Magnetic disk, CD-Rom, Multimedia, Internet, E-mail and Mobile technology.

(c) Conventional and non-conventional energy sources, Nuclear energy, Solar energy, Biomass energy, Wind energy, Geothermal energy, Tidal and wave energy, Future alternative sources of energy.

Reference Books:

1. Undergraduate Physics – Vol. III, A. B. Bhattacharya & R. Bhattacharya, New Central Agency (P) Ltd.
2. Electronic Principles and Applications – A. B. Bhattacharya.
3. University Physics with Modern Physics – Sears & Zeemansky, 12th edition by Young & Freedman, Pearson Education.
4. Electronics Made Simple – Henry Jacobowitz Vakils, Feffor & Simons Ltd. Bombay.
5. Intermediate Physics - Vol. I & II, Roychoudhury, Sinha & Srivastaba, Modern Book Agency, Pvt. Ltd., Kolkata.

PHY 104: PRACTICAL (OPTICS)
Full Marks - 100

List of Experiments: (Group -A) - 50 Marks

1. Determination of wavelength of light by biprism.
2. Determination of wavelength of light by bimirror.
3. Measurement of wavelength of light using a narrow wire.
4. Measurement of wavelength of light by using a straight edge.
5. Verification of Brewster's law.
6. Verification of Fresnel's laws of reflection of polarized light & analysis of elliptically polarized light using a quarter wave plate.
7. Analysis of elliptically polarized light using a Babinet's compensator.
8. Determination of resolving power of a telescope.

List of Experiments: (Group-B) - 50 Marks

1. Determination of resolving power of grating.
2. Determination of resolving power of prism spectroscope.
3. Measurement of wavelength of light by Michelson interferometer.
4. Measurement of thickness of mica sheet by Michelson interferometer.
5. Measurement of difference between wavelengths of sodium D-lines by Michelson interferometer.
6. Determination of wavelength of light by a Fabry – Perot interferometer.
7. Determination of the difference between the wavelength of sodium D lines using a Fabry – Perot interferometer.
8. Determination of thickness of the air film by a Fabry-Perot etalon.

SECOND SEMESTER

PHY - 201: QUANTUM MECHANICS-I

Full Mark 50 (10 Mid Term + 40 End Term)

UNIT - I: General Principles of Quantum Mechanics

Linear vector space, ket and bra vector, scalar product of vector and their properties, linear operators, adjoint operators; unitary operators; expectation values of dynamical variables and physical interpretation. Hermitian operators, eigen values and eigenvectors, orthonormality of eigen vectors; Probability interpretation; degeneracy, Schmidt's method of orthogonalization.

Expansion theorem, completeness and closure property of the basis set; co-ordinate, momentum and energy representation.

Compatible and incompatible observables: commutator algebra: uncertainty wave packet.

Unit - II: Quantum Dynamics: Time evolution of quantum states, time evolution of operator and its properties, Schroedinger picture, Heisenberg picture, Interaction picture, Equation of motion, operator method of solution of harmonic oscillator problem: matrix representation and time evolution of creation and annihilation operators, density matrix.

Unit - III: Rotational & Orbital angular Momentum: Rotation matrix, angular momentum operators as generators of rotation L_x L_y L_z and L^2 and their commutation relations, raising & lowering operators L & L; L_x L_y L_z and L^2 in spherical polar coordinates; eigen values and eigen functions of L_z & L^2 (operator method), spherical harmonics; matrix representation of L_x L_y L_z and L^2.

Spin Angular Momentum

Spin -$^1/_2$ particles, Pauli spin matrices and their properties, eigen values and eigen functions, spinor transformation under rotation.

Addition of Angular Momentum: Total angular momentum J; eigen value problem J_z and J^2 angular momentum matrices: addition of angular momenta and Clebsch - Gordan coefficients; angular momentum states for composite system in the angular momenta ($^1/_2$, $^1/_2$) and (1, $^1/_2$).

PHY – 202: NUCLEAR & PARTICLE PHYSICS

Full Mark 50 (10 Mid Term + 40 End Term)

Unit I: Basic Nuclear Properties: Theories of nuclear composition, Elementary ideas on nuclear spin and angular momentum, Isospin & Parity. Quantum statistics, Nuclear magnetic dipole moment, Electric quadrapole moment; Nuclear size and its determination by scattering and electromagnetic methods.

Nuclear Forces: Concept of nuclear forces, Properties of deuteron (ground state of deuteron for central force only), Exited state of deuteron , Magnetic moment of deuteron; neutron-proton (n-p) and proton - proton (p-p) scattering at low energies, similarity of (n-n) & (p-p) forces, saturation of nuclear forces (elementary idea).

Unit II: Nuclear Models: Fermi Gas Model: Liquid drop model, Shell model (extreme single particle model, energy levels and magic numbers from square well, harmonic oscillator and spin orbit potential), Elementary ideas of collective model.

Nuclear Reactions and Radio Activity: Nuclear reaction kinematics, Nuclear scattering and reaction cross-section using partial wave analysis resonance (Breit-Wigner dispersion formula), Compound nucleus hypothesis.

Gamow theory of alpha decay, Fermi theory of beta decay, Parity violation in beta decay, nuclear fission and fusion.

Unit III: Particle Physics: Ideas on strong, Electromagnetic, Weak and Gravitational forces; Classification of elementary particles and their spin, Parity, Concept of isospin, Strangeness, Lepton and baryon number, Conservation laws, Gellmann-Nishjima scheme, Meson and baryon, Octet, Elementary ideas of su(3) symmetry, Quark model.

PHY – 203: ELECTRODYNAMICS

Full Mark 50 (10 Mid Term + 40 End Term)

Unit - I: Maxwell's Equations: Vector and scalar potentials, Lorentz and Coulomb gauge, Gauge invariance, Plane electromagnetic waves in non conducting medium, Poynting's theorem and conservation of energy and momentum, Solution of the wave equation by Green's function formalism, Frequency dispersion characteristics of dielectrics, Conductors and plasma.

Waveguides & Resonant Cavities: TE & TM modes in dielectric slab waveguides, Cylindrical cavities and wave guide, Modes in rectangular waveguide, Resonant cavities.

Unit II: Radiations and Scattering: Fields and radiation of a localised oscillating source, Electric and magnetic dipole fields and radiation, Center fed linear antenna with sinusoidal current, Scattering by a small dielectric sphere in long wavelength limit.

Radiations by Moving Charges: Lienard-Wiechert potential and field due to a point charge, Total power radiated by an accelerated charge, Larmour's formula, Angular distribution of radiation from an accelerated charge, Thomas scattering of radiation.

Unit III: Relativistic Mechanics and Electrodynamics: The four vector notation, Lorentz transformation of particle kinematics, Co-variant formulation of Maxwell's equations, Electromagnetic field tensor, Co-variant definitions of electromagnetic energy and momentum, Transformation of electromagnetic field components.

PHY – 204: PRACTICAL (ELECTRICITY & ELECTRONICS)

Full Marks -100

List of Experiments (Group -A) - 50 Marks

1. De-Sauty's Bridge
2. Owen's Bridge
3. Anderson's Bridge
4. Maxwell's Bridge for determination of 'L'
5. Maxwell's Bridge for determination of 'M'
6. Power factor of fan.
7. Carey - Foster Bridge (Comparison of nearly equal resistances)
8. Measurement of Ballistic constant by standard solenoid inductor
9. Measurement of Ballistic constant by Hibbert's magnetic standard

List of Experiments (Group - B) - 50 Marks

1. Static characteristics of Triode, Tetrode and Pentode Valves.
2. R-C Coupled amplifier.
3. Transistor characteristics.
4. Diode as a detector and its detection characteristics.
5. Study of OR, AND, NOT, NAND, NOR Logic gates.
6. Measurement of current, voltage and frequency with CRO.
7. Setting up, calibration & experiments with VTVM.

THIRD SEMESTER

PHY – 301: QUANTUM MECHANCS –II

Full Mark 50 (10 Mid Term + 40 End Term)

UNIT - I: Central Force Problem: Hydrogen atom, reduction to equivalent one dody problem, radial equation, energy eigen value and eigen function, degeneracy, radial probability distribution: Three dimensional oscillator.

Scattering: Scattering amplitude and cross section: Born approximation, application to Coulomb and screened Coulomb potentials; Partial wave analysis for elastic and inelastic scattering; effective range and scattering length, optical theorem.

Unit II: Approximation Methods: Stationary perturbation theory, Rayleigh – Schroedinger method for non degenerate case, first and second order perturbation, General theory for the degenerate case, removal of degeneracy, linear and quadratic Stark effect, normal and anomalous Zeeman effect, fine structure of spectral lines of H - like atoms.

WKB Method: Connection formulae, application of WKB approximation method.

Variational Methods: Ground state of the H- atom and He - atom.

Perturbation Theory: Transition probability, constant and harmonic perturbation, Fermi's golden rule, electric dipole radiation and selection rules.

Unit III: Dirac Theory of Electron: Klein Gordon equation and failure of Klein Gordon equation, Derivation of Dirac equation - properties of Dirac matrices, non - relativistic reduction of Dirac equation, magnetic moment, Darwin's term, spin – orbit coupling, Covariant form of Dirac equation, bilinear Co-Variants. Free particle solution of Dirac equation, projection operators for energy and spin, physical interpretation of free particle solution, Zitterbewegung hole theory.

PHY 302: SOLID STATE PHYSICS

Full Mark 50 (10 Mid Term + 40 End Term)

Unit - I: Crystal Binding: Crystal of Inert gases: ionic crystals, covalent crystals and metal crystals, and metal crystals.

Phonons & Lattice Vibration: Quanitization of lattice vibrations, Phonon momentum, inelastic scattering of photons by long wave length phonons, inelastic scattering of X-rays and neutrons by phonons, vibrations of monoatomic and diatomic lattices, optical properties in the infrared.

Thermal Properties of Solids: Lattice heat capacity, Einstein and Debye model, Thermal conductivity.

Unit -II: Di - electric Properties of Solids: Di - electric constant, polarizability, dielectric relaxation time.

Free Electron Fermi Gas: Density of states in one dimension, effect of temperature of Fermi - Dirac distribution, free electron gas in three dimensions, heat capacity of electron gas: electrical and thermal conductivity of metals. Band theory: Origin of the energy gap, Bloch function, wave equation of electron in a periodic potential approximate solution near Zone boundary.

Unit - III: Magnetic Properties of Solids: Quantum theory of diamagnetism, quantum theory of papamagneatism, paramagnetism (Pauli) of conduction electrons, Curie point and exchange integral, saturation magnetisation.

Superconductivity: Experimental survey, Meisner effect, thermodynamics of the superconducting transition, London equation, Elements of BCS theory.

PHY-303: ELECTRONICS OR ADVANCED OPTICS & SPECTROSCOPY (SPECIAL - I)

Full Mark 50 (10 Mid Term + 40 End Term)

ELECTRONICS

Unit - I: Electronic Network & Network Theorems

Mesh and node circuit analysis, reduction of network, conversion between T and π sections, bridged T & Lattice networks, superposition theorems, reciprocity theorem, Thevenin's theorem, Norton's theorem, composition theorem and maximum power transfer theorem, driving point impedance transfer impedance.

Conduction in the Solid State: The intrinsic semiconductor, n & p materials, charge densities in n & p materials, conduction by charge drift, conduction by diffusion of charge, the p-n junction, the p-n diode equation.

Unit - II: Bipolar transistor and FET: The bipolar junction transistor, current and voltage notation, currents and current gains, volt – ampere relations for the bipolar junction transistor, the load line, the small signal requirement, voltage breakdown, the Ebers - Moll model, Field, - effect transistor, the MOS field effect transistor, circuit characteristics of FET.

Active Networks & Transistor: Two port network analysis, controlled sources, active circuit models, transfer impedances, gain in decibels, an equivalent circuit for the BJT, the trans conductance model, the common- emitter amplifier, the common-base amplifier, the common colector amplifier, summary of amplifier performance, conversion of the h parameters, the equivalent circuit for the FET, the common- source amplifier, the source follower circuit.

Unit - III: Feedback Principle: An amplifier "Black Box" with feed back, stabilization of gain by negative feedback, reduction of non linear distortion by negative feed back, effect of feed back on output resistance, effect of feedback on input resistance, Voltage - series feed back, Voltage - shunt feed back, Current - series feed back.

Bias for Transistor Amplifier: Location of the quiescent point for the bipolar transistor, variation of the bias current, fixed bias, emitter-feedback bias, design of an emitter-feedback bias circuit, bias for the FET, Voltage - feedback bias, bias for the emitter follower.

ADVANCE OPTICS AND SPECTROSCOPY

Full Mark 50 (10 Mid Term + 40 End Term)

ATOMIC SPECTRA

Unit I: Sommerfeld's theory of hydrogen atom, fine structure of spectral lines, space quantization; quantum mechanical treatment on hydrogen atom and the quantum numbers n, l, and m.

Different series in alkali spectra; Ritz combination Principle, term values and quantum defect, penetrating and non penetrating orbits, doublets fine structure, selection rule and intensity rule.

Unit - II: The spinning electron and vector model, electron spin orbit interaction and the doublet fine structure, spin – orbits interaction energy of penetrating and non-penetrating orbits.
The normal Zeeman effect, the anomalous Zeeman effect and the Paschen-Back effect in one electron systems.

Unit - III: The atom model for two electron system. L-S and J—J coupling; the Lande interval rules; the Zeeman and Paschen-Back effects: the Pauli exclusion principle.
The Principles of nuclear magnetic resonance spectroscopy, electron - spin resonance spectroscopy, resonance condition, g-factor.

PHY - 304
PRACTICAL ON MODERN PHYSICS & COMPUTERS
Full Marks - 100 Marks

List of experiments on modern physics: (Group-A) - 50 Marks

1. Verification of Richardson's thermionic emission formula.
2. Use of optical pyrometer.
3. Measurement of velocity of light & dielectric constant by Lecher's wires.
4. Measurement with G.M. counter.
5. Spectral sensitivity of Photo - electric cell.
6. Determination of Planck's constant by total radiation method.
7. Ultrasonic measurement.
8. Experiments on Hall effect
9. Determination of
   (a) e/m by Braun tube
   (b) e/m by hellical method
   (c) 'e' by Millikan's oil drop experiment.
   (d) e/m by magnetron valve.
10. Setting of multivibrator and measurement of voltage, current, time and frequency with cathode ray oscilloscope.
11. Measurement of resistivity of semiconductor by four probe method.

List of experiments with computer: (Group-B) - 50 Marks

1. Preliminary Commands on UNIX.
2. Text formatting using VI Text Editor of UNIX.
3. Text formatting using MS Word.
4. EXCEL
5. Power Point
6. Programming with Fortran and its application to numerical methods for evaluation of definite integrals by Simpson Rule, Trapzoidal Rule and Gauss quadrature method.
7. Solving Transcendental equation by half interval search an Newton - Rapson method.
8. Solving first order differential equation using Runga Kutta method.

SEMESTER – IV

PHY 401: STATISTICAL MECHANICS

Full Mark 50 (10 Mid Term + 40 End Term)

Unit I: Classical Statistical Mechanics: Postulates of classical statistical mechanics. Liouvill's theorem. microcannonical ensemble, derivation of thermodynamics, equipartion theorem, classical ideal gas, Gibb's paradox.

Canonical and Grand Canonical Ensemble: Canonical ensemble and energy fluctuation, grand canonical ensemble and density fluctuation, equivalence of canonical and grand canonical ensemble.

Unit-II: **Quantum statistical Mechanics**: Postulates of quantum statistical mechanics, density matrix, ensembles in quantum stastical mechanics, ideal gases in microcanonical and grand canonical ensemble.

Unit III: Ideal Fermi Gas: The equation of state of ideal Fermi gas, Puali Paramagnetism.
Ideal Bose Gas: Photons, Planck's law, Bose - Einstein Condensation.
Liquid Helium -II: The phase transition, Landau theory of liquid Helium II

PHY – 402: ELECTRONICS OR ADVANCED OPTICS & SPECTROSCOPY (Special – II)

Full Mark 50 (10 Mid Term + 40 End Term)

ELECTRONICS

Unit-I: Frequency response of Linear Amplifiers: The RC coupled CE amplifier, the frequency response of the RC amplifier, Gain - frequency plots of amplifier response, Band width of cascaded amplifiers, bandwidth criteria for the transistor, the gain- bandwidth product, bandwidth increased with negative feedback, bootstrapping the FET, amplifier stability wish feedback, noise in amplifiers.

Tuned and Wide Band Amplifiers: Band-pass amplifiers, the parallel-resonant circuit, impedance variation at frequencies near resonance, bandwidth of the parallel resonant circuit, transformation from the series-resistance form, inductively-coupled circuits, the tuned - primary amplifier, the tuned-secondary FET amplifier, impedance, adjustment with tapped cricuit, the double tuned transformer.

Unit - II: Operational Amplifier: Integrated amplifiers, the differential amplifier, rejection of common mode signals, the operational amplifier, input and output impedances, the slew rate, input offset voltage, input offset current.

Applications of Operational Amplifiers: The operational amplifiers, the unity gain buffer, the adding operation, the integration operation, the comparator, analog computation, a logarithmic amplifier.

Unit - III: Power Amplifiers: Operating conditions for power amplifiers, power relations, the class A power amplifier, transistor operating temperatures, thermal stability of the power transistor, the push pull principle, the class B push-pull amplifier, the class B linear radio frequency amplifier, the class C resonant load amplifier.

Oscillator Principles: Feedback requirements for oscillations, circuit requirements for oscillation, basic oscillator analysis, Piezoelectric frequency control, resistance - capacitance oscillators.

ADVANCED OPTICS & SPECTROSCOPY SPECTRA OF DIATOMIC MOLECULE

Full Mark 50 (10 Mid Term + 40 End Term)

Unit-I: Infrared and Raman Spectra - Molecule as (a) rigid rotator and (b) harmonic oscillator, energy levels, eigen functions, and selection
Classical theory of Raman effect and selection rules, for Raman scattering: quantum theory of Raman effect: vibrational and rotational Raman spectrum.

Unit-II: The molecule (i) anharmoic oscillator (ii) non- rigid rotator (iii) the vibrating rotator and (iv)symmetric top (energy levels, eigen functions), infrared Raman spectra, thermal distribution of quantum states: intensity of rotation spectra.

Unit-III: Electronic states and electronic transition, electronic energy and total energy of diatomic molecules, vibrational structure of electronic bands: the branches of a band: Deslander's tables, progression and sequences, rotational structure of electronic band: intensities of electronic band Franc - Condon principle (wave-mechanical formulation).

PHY 403: ELECTRONICS OR ADVANCED OPTICS & SPECTROSCOPY (SPECIAL -III)

Full Mark 50 (10 Mid Term + 40 End Term)

ELECTRONICS

Unit - I: Modulation and Frequency Conversion: Fundamental of modulation, frequency spectrum in amplitude modulation, power in the AM wave, methods of amplitude modulation, the modulated class C amplifier, efficiency modulation, linear demodulation of AM signals, automatic volume control, frequency conversion, the SSB system, the balanced modulation, the product detector, the frequency spectrum for FM, diode FM generation, the amplitude limiter, FM demodulation with the discriminator.

Special Semiconductor Devices: Principle, working and application of UJT, SCR TRIAC, Zener diode, tunnel diode, impatt diode, photoconductor, photovoltaic cell, solar cells.

Unit II: Digital Circuits: The binary number system and other codes, binary arithmetic, logic fundamentals, Boolean theorems, the exclusive- OR operations, the Karnaugh diagram, Logic circuit for addition, logic gates, the NOT or inversion operation OR, NOR, NAND, combinational circuit, half & full adder, diode -transistor logic, resistance - transistor logic gates, transistor transistor logic gates, emitter coupled logic gates.

Digital Switching using Integrated Circuits: The RS flip flops, the D-flip flop, the T or toggling flip flop, the JK flip flop, the Schmidt trigger, the mono stable multivibrator, the astable multivibrator, the shift register; counting, decoder matrices, binary comparison, sampling of analog signals, sample conversion to digital form, digital to analog conversion, multiplex use of a wide frequency band.

Unit III: Wave Shaping Circuits: Linear wave shaping circuit, RC, LCR circuits, non linear wave shaping circuits, clipping and clamping circuits, blocking oscillator, time-base generators.

Lasers and Optoelectronics: Physics of Laser Emissions, Spontaneous and stimulated emission, Population inversion, Einstein's coefficients, Threshold condition, Different classes of Lasers (i) Doped Insulator type (ii) Semiconductor (Ga-As) and hetero Junction Lasers (iii) Gas Lasers and molecular Lasers (iv) Liquid dye Lasers.
Laser Resonant cavities, Different types of modes in the cavity, Q-switching.
Output characteristics of Semiconductor Laser diodes and LEDs, Elementary idea about optical fibre communication, properties of Lasers and applications.

ADVANCE OPTICS & SPECTEROSCOPY

Full Mark 50 (10 Mid Term + 40 End Term)

Unit - I: Physics of Laser Emission, Spontaneous and stimulated emission, Population inversion, Einstein's coefficients, Threshold condition, Different classes of Lasers (i) Doped Insulator type (ii) Semiconductor (Ga-As) and hetero Junction Lasers (iii) Gas Lasers and molecular Laser (iv) Liquid dye Lasers, with examples of each class, Ruby Laser & Helium - Neon Laser.

Unit - II: Optical Resonators, modes of a rectangular cavity, the quality factor, the ultimate line width of laser, Transverse and Longitudinal mode achieving single mode Laser, Q-Switching.

Unit - III: Properties of Lasers, Coherence (Temporal and Spatial), Directionality, Brightness, Focusing and Tunebility, Characteristics of Semiconductor Laser, Diodes and LEDs, Applications of Lasers based on its properties, Spatial frequency filtering, Elementary ideas about holography, Holograms.

PHY – 404: PRACTICAL (ELECTRONICS-SPECIAL)

List of experiments on Electronics: (F. Marks - 40 Marks)

1. Characteristics of Zener diode.
2. Characteristics of transistor (B.J.T)
3. Characteristics of U.J.T
4. Characteristics of silicon and controlled rectifier.
5. Characteristics of F.E.T
6. Network Theorem.
7. De Morgan's Theory
8. Study for OR, AND, NOR, NAND, NOT, Logic gates
9. Study of OPAMP.

PRACTICAL (ELECTRONICS-SPECIAL - II)

List of experiments on Electronics: (F. Marks - 40 Marks)

1. Study of multistage voltage and power amplifier.
2. Study of Laboratory power supply.
3. Study of multivibrator.
4. Study of R-C coupled amplifier.
5. Study of Phase shift amplifier.
6. Study of Hartley oscillator.
7. Study of amplitude modulation and measurement of modulation.
8. Study of frequency response with Negative Feed Back.
9. Measurement of wavelength by Lecher wire.

OR

PRACTICAL (ADVANCE OPTICS & SPECTEROSCOPY (SPECIAL - I)

List of experiments on Advance Optics & Spectroscopy (F. Marks - 40 Marks)

1. Increased linear dispersion graph of large prism spectrograph.
   (i) Constant deviation spectrograph
   (ii) Large Prism spectrograph
2. Ionization potential of sodium atom.
3. Wave length of copper spectra using iron as standard
4. Identification of basic radical of a given salt.
5. Dissociation energy of cyanogens.

PRACTICAL (ADVANCE OPTICS & SPECTEROSCOPY (SPECIAL - II)

List of experiments on Advance Optics & Spectroscopy (F. Marks - 40 Marks)

1. Dissociation energy of $Al_2 O_3$
2. Dissociation energy of Nitrogen.
3. Determination of the value of Rydberg constant of hydrogen.
4. Study of Zeeman effect and determination of value of elm
5. Characteristics of LED (Light Emitting Diode) and L D (laser Diode
6. Experiments with a Laser kit.

SEMINAR AND PROJECT ON SPECIAL PAPER

Full Marks – 20

Each student has to submit a minor project related to the special paper for valuation or perform an experiment related to diode laser.

List of equipment / experiments for project / dissertation based on diode lasers (B. S. R. lab under UGC programme).

1. Standard laser kit
2. Michelson's Interferometer
3. Fabry-Perot Interferometer
4. Apparatus for determination of particle size
5. Brewster's angle apparatus
6. Goiniometer apparatus
7. Malus law apparatus

This will be examined by external and internal examiners during practical examination of Semester IV i.e. paper Phy-404

Reference Books for M. Sc. Physics (Theory)

1. Classical Mechanics - H. Goldstein
2. Mechanics - Landau and Lifshitz.
3. Classical Mechanics of Particles and Rigid Bodies - Kiran C. Gupta
4. Mathematical Methods for Physicists - Mathews and Walker
5. Mathematical Methods of Physics-Mathews and Walker
6. Mathematical Physics - P. K. Chattopadhyay
7. Mathematical Physics - Satya Prakash
8. Mathematical Physics - Gupta and Rajput
9. Fortran 77 and Numerical Methods - C. Xavier (Wiley Eastern Ltd)
10. Quantum Mechanics – L SehiffI
11. Quantum Physics - S. Gasiorowitz

12. Quantum Mechanics - E. Merzbaker
13. Quantum Mechanics -A. Messiah (Vol. I & II)
14. Quantum Mechanics - Dicke and Witke
15. Quantum Mechanics - Powel and Craftsman
16. Quantum Mechanics - Ghatak and Lokanathan
17. Quantum Mechanics - Chatwal and Anand
18. Relativistic Quantum Mechanics - Bjorken and S.D. Drell
19. Classical Electrodynamics - J. D. Jackson
20. Principles of Optics - Max Born and E. Wolf
21. Electrodynamics - Gupta Kumar and Singh
22. Electronic Fundamentals and Application - J. D. Ryder
23. Foundation of Electronics – Chattopadhyay, Rakshit and Purkaito
24. Handbook of Eletronics - Gupta and Kumar
25. Electrodynamics - S. P. Puri
26. Statitical Mechanics - K. Huang
27. Statistical Mechanics - S. K. Sinha
28. Statistical Physics - L. D. Landau and E.M. Lifshitz.
29. Introduction to Solid State Physics - C. Kittel
30. Solid State Physics - O.E. Animalu
31. Solid State Physics -A.J. Dekker
32. Solid State Physics - An Introduction to Theory / Experiment - H. 1. Hons Lath
33. Nuclear Physics - R. R. Roy and B. P. Nigam (Wiley Eastern)
34. Nuclear Physics - D.C. Tayal (Himalaya Publishing House)
35. Nuclear Physics - I. Kaplan
36. Nuclear Physics - E. Fermi
37. Introductory Nuclear Physics - L. R. B. Elton
38. Elementary Particle Physics - G. Kallen
39. Elementary Particle Physics - W.R. Frazer
40. Elementary Particle Physics - M.J. Longo
41, Introduction to Atomic Spectra - H. E. White
42. Spectra of Diatomic Molecules - G. Herzberg
43. Atomic Spectra - Chandler
44. Quantum Mechanics - Gupta, Kumar & Sharma
45. Quantum Mechanics - S. N. Biswas
46. Mathematical Physics - B. S. Rajput
47. Advanced Quantum Mechanics - B. S. Rajput
48. Classical Mechanics - Gupta, Kumar & Sharma
49. Solid state Physics - Saxena, Gupta & Saxena
50. Hand book of Electronics - Gupta, Kumar
51. Quantum Mechanics - S. N. Biswas
52. Electronics (Classical & Modern) - R. N. Kar
53. Quantum Mechanics - Pauling and Wilson
54. Spectroscopy- B. P. Starngham and S. Walkar
55. Spectroscopy - and Molecular Structure - G.W. King
56. Optics -A. K. Ghatak
57. Lasers. Theory and Application - K. Thyagrajan and A. K. Ghatak

****

SEMESTER SYSTEM OF P. G. PHYSICS

SEMESTER SYSTEM OF P. G. PHYSICS

SEMESTER SYSTEM OF P. G. PHYSICS