MODIFIED CBCS CURRICULUM OF

M.Sc. PHYSICS PROGRAMME

SUBJECT CODE = PHY

FOR POST GRADUATE COURSES UNDER RANCHI UNIVERSITY

Implemented w.e.f.
Academic Session 2018-2020

Members of Board of Studies of CBCS P.G. Syllabus as per Guidelines of the Ranchi University, Ranchi.

1. **Chairman** –

   Dr. Vinita Sharan
   Associate Professor & Head,
   University Department of Physics, Ranchi University, Ranchi

2. **Internal Members-**

   i. **Dr. Arun Kumar**
   Associate Professor,
   University Department of Physics, Ranchi University, Ranchi

   ii. **Dr. Sanjay Kumar Dey**
   Associate Professor,
   University Department of Physics, Ranchi University, Ranchi

   iii. **Dr. Achint Kapoor**
   Associate Professor,
   University Department of Physics, Ranchi University, Ranchi

   iv. **Dr. Sudha Singh**
   Associate Professor,
   University Department of Physics, Ranchi University, Ranchi

   v. Sri Arun Kumar
   Assistant Professor
   University Department of Physics, Ranchi University, Ranchi

   vi. Dr. Raj Kumar Singh
   Assistant Professor
   University Department of Physics, Ranchi University, Ranchi

3. **External Members:-**

   i. Prof. (Retd.) N. R. Roy
   University Department of Physics, Ranchi University, Ranchi

   ii. Prof. P. Mahato
   Former Professor, VBU, Hazaribag
   Registrar, BBM University, Dhanbad

4. **Special Invitee:-**

   1. **Prof. S. N. Singh**
   Professor (on lien), University Department of Physics, Ranchi University, Ranchi
   Vice-Chancellor, NPU, Medininaga

16/3/19

H.O.D.
Head
University Department of Physics
Ranchi University, Ranchi

Contents

COURSE STUCTURE FOR M.Sc. PHYSICS

Table AI-1: Distribution of 80 Credits for Subjects having Practical Papers

[*wherever there is a practical examination there will be no tutorial and vice –versa.]

Course	Papers	Credits Theory + Practical	Credits Theory + Tutorial
I. Foundation Course (FC)			
1. Foundation Course Compulsory Foundation/ Elective Foundation	**(FC)** 1 Paper	1X5=5	1X5=5
II. Core Course (CC)	**(CC 1 to 10/11)**		
Theory	7 Papers/11 Papers	7X5=35	11X5=55
Practical/ Tutorial*	3 Papers/----------	3X5=15	
Project	1 Paper	1X5=5	1X5=5
III. Elective Course (EC)			
A. Ability Enhancement Course of the Core Course opted	**(AE/EC 1)** 1 Paper	1X5=5	1X5=5
B. Discipline Centric Elective	**(DC/EC 2&3)**		
Theory + Practical	2 Papers 1 Paper	2X5=10 1x5=5	
OR Theory/Practical/Tutorial*	1Paper + 1 Practical/Dissertation		2X5=10
OR Generic Elective/ Interdisciplinary	**(GE/EC 2&3)**		
Theory OR Theory/Practical/Tutorial*	2 Papers 1 Paper + 1 Practical/Dissertation		
	Total Credit = 80		**= 80**

Table AI-1.1: Course structure for M.Sc Programme with Practical Papers

Semester	Subject (Core Courses) 11 Papers	Allied (Elective Courses) 4 Papers	Foundation Course (Compulsory Course) 1 Paper	Total Credits
Sem-I	C-1, C-2, C-3 (5+5+5=15 Credits)		Foundation Course FC (05 Credits)	**20 Credits**
Sem-II	C-4, C-5, C-6, C-7 (5+5+5+5=20 Credits)			**20 Credits**
Sem-III	C-8, C-9, C-10 (5+5+5=15 Credits)	EC1 (05 Credits)		**20 Credits**
Sem-IV	C-11 (Project) (05 Credits)	EC2, EC3, EP (5+5+5=15Credits)		**20 Credits**
				Total = 80 Credits

COURSES OF STUDY FOR M.Sc. PHYSICS **2018 onwards**

Table AI-2 Subject Combinations allowed for M. Sc. Programme (80 Credits)

Foundation Course **FC** **1 Paper**	Core Subject **CC** **11 Papers**	Ability Enhancement Course **AE** **1 Paper**	Discipline Centric Elective/ Generic Elective Course **DC/ GE/ EC** **3 Papers**

Table AI-2.1 Semester wise Examination Structure for Mid Sem & End Sem Examinations:

Sem	Core, SE/ GE/ DC/ EC & Compulsory FC Courses				Examination Structure		
	Paper	Paper Code	Credit	Name of Paper	Mid Semester Evaluation (F.M.)	End Semester Evaluation (F.M.)	End Semester Practical/ Viva (F.M.)
I	Foundation Course	FCPHY101	5	Mathematical Methods in Physics	30	70	----
	Core Course	CCPHY102	5	Quantum Mechanics-I	30	70	----
	Core Course	CCPHY103	5	Solid State Physics and General Electronics	30	70	----
	Practical's on Core	CPPHY104	5	Practical-I	----	----	70 + 30
II	Core Course	CCPHY201	5	Spectroscopy	30	70	----
	Core Course	CCPHY202	5	Quantum Mechanics -II	30	70	----
	Core Course	CCPHY203	5	Nuclear Physics – I	30	70	----
	Practical's on Core	CPPHY204	5	Practical-II	----	----	70 + 30
III	Ability Enhancement Course	CCPHY301	5	A. Numerical Methods and Simulation/ B. Experimental Techniques	30	70	----
	Core Course	CCPHY302	5	Statistical Physics	30	70	----
	Core Course	CCPHY303	5	Nuclear Physics – II	30	70	----
	Practical's on Core	CPPHY304	5	Practical-III	----	----	70 + 30
IV	Elective	ECPHY401	5	A. Nanophysics and Nanomaterials – I/ B. Electronics and Communication – I C. Condensed Matter Physics -I	30	70	----
	Elective	ECPHY402	5	A. Nanophysics and Nanomaterials-II/ B. Electronics and Communication-II/ C. Condensed Matter Physics -II	30	70	----
	Practical's on Elective	EPPHY403	5	A. Practical-IV: Nanophysics & Nanomaterials/ B. Practical-IV: Electronics & Communication/ C. Practical-IV: Condensed Matter Physics	----	----	70 + 30
	PROJECT	PRPHY404	5	Project Work	----	----	70 + 30

SEMESTER I **4 Papers**

Total 100 x 4 = 400 Marks

I. COMPULSORY FOUNDATION COURSE [FCPHY101]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	**Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

MATHEMATICAL METHODS IN PHYSICS

Theory: 60 Hours; Tutorial: 15 Hours

Matrices and Tensors: Introduction of matrices through rotation of co-ordinate systems, Orthogonal, Hermitian, Unitary, Null and Unit matrices, Singular and Non-singular matrices, Inverse of a matrix, Trace of a matrix, Eigenvalues and Eigenvectors, Diagonalization. Tensorial character of physical entities, Covariant, Contravariant and Mixed tensors, Contraction, Quotient rule, Differentiation, Kronecker tensor, Pseudotensor, Symmetric and Anti symmetric tensors.

15 Lectures

Green's Function: Introduction Construction of the Green's function for 1d, 2d and 3d problems. Solution of some standard problems using Green's function technique.

5 Lectures

Group Theory: Definition and examples of physically important finite groups, Basic symmetry operations and their matrix representations, Multiplication table, Cyclic groups and subgroups, Classes. Reducible and Irreducible representation, Schur's lemma, Orthogonality theorem, Character of a representation, Construction character tables.

15 Lectures

Electrodynamics and Relativity: Lorentz transformation as orthogonal transformation in 4-dimensions, 4-vectors and light cone, energy-momentum 4-vectors, Relativistic force equation,

Covariance of Maxwell's equation, Transformation of electromagnetic fields, Solution of wave equation in covariant form, Field due to a charge moving with constant velocity, Radiation from oscillating dipole, Total power radiated from an accelerated charge, Larmor formula, Principle of equivalence, Principle of covariance, Covariant differentiation, Curvature tensor, field equation, Reduction to Newton's laws of gravitation.

25 Lectures

Signal Processing and Data Analysis: Fast transforms, Random noise and signal, White and coloured noise, Power spectrum, Convolution, Auto-correlation and cross-correlation, Matched filtering techniques, Maximum entropy method.

15 Lectures

Books Suggested:

- Mathematical Methods for Physicists, G.BArfken, H.J.Waber, E.E. Harris, 2013, 7thEdn., Elsevier.
- Boas, M.L., "Mathematical Methods in Physical Sciences", Wiley International Editions.
- Group Theory and Quantum Mechanics, M.Timkham.
- Mathematical Physics: Das and Sharma.
- Mathematical Methods for Physicist & Engineers: Pipes & Harvel.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical Methods for Scientists and Engineers: D.A.McQuarrie, 2003, Viva Book.
- Advanced Engineering Mathematics: D.G.Zill and W.S.Wright, 5-Ed, 2012, Jones and Bartlett Learning.
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.
- Classical Electrodynamics, J.D.Jackson, 3rd Edn, 1988, Wiley.
- The Classical Theory of Fields, L.D.Landau, E.M.Lifshitz, 4th Edn. 2003, Elsevier.
- Electromagnetic Field Theory for Engineers & Physicsts, P.Lorrain & D.Corson, 1970.

II. CORE COURSE [CCPHY102]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

QUANTUM MECHANICS-I **Theory: 60 Hours; Tutorial: 15 Hours**

Mathematical Foundation of Quantum Mechanics: Vectors and Linear vector space, Closure property, Linear independence of vectors, Bases and dimensions. Some examples of linear vector spaces, Dirac's notations, Bra and Ket vectors, Combining bras with kets, Inner product and inner product space, Orthonormality of vectors, Gram Schmidt orthogonalization of vectors in a linear vector space, Schwartz inequality, Arbitrary Vectors in an orthonormal basis, Completeness condition, Outer product, Hilbert spaces, Operator on a linear vector space, Algebra of linear operators, , Hermitian operators and their properties, Unitary, Projection, Commuting operators and related theorems, Complete set of commuting operators, Eigenvalues and eigenfunctions (continuous and bounded operators), Co-ordinate and momentum representation, Time differentiation of operators. **30 Lectures**

Hilbert Space Formalism of Quantum Mechanics: Postulates, Expectation values and probabilities, Explicit representation of operators, The general uncertainty relationship, The minimum uncertainty product. **8 Lectures**

Quantum Dynamics: The equation of motion- The Schrodinger; the Heisenberg and the Interaction pictures; Applications to linear harmonic oscillator and the hydrogen atom. Linear harmonic oscillator using Creation and annihilation operator. **12 Lectures**

Heisenberg Matrix Mechanics: Matrix representation of states and operators, Matrix transformation, Diagonalizability of matrix, Application to linear harmonic oscillator problem. **8 Lectures**

Angular Momentum: Commutation relations for angular momentum operators, Eigenvalues and eigenvectors, Pauli spin matrices and spin eigenvectors, Addition theorem, Clebsch- Gordon co-efficient, Angular momentum and rotation, Motion in a centrally symmetric field. **8 Lectures**

Invariance Principle and Conservation Laws: Space-time symmetries and conservation Laws for linear momentum, Angular momentum, Energy and Parity. **8 Lectures**

Books Suggested:

- Mathews, P.M., &Venkatesan, K., "A Text Book of Quantum Mechanics", TMH.
- Merzbacker, E., "Quantum Mechanics", John Wiley
- Messiah, A., "Quantum Mechanics", North-Holland Publishing Co.
- Schiff, L.I., "Quantum Mechanics", Tata McGraw-Hill, 3rd Edition 2010
- Ghatak, A., Quantum Mechanics", Narosa Publishing House, New Delhi.
- Agarwal, B. K., "Quantum Mechanics', PHI
- Landau, L.D. &Lifshitz, E.M., "Quantum Mechanics", Pergman Press
- Quantum Mechanics for Scientists and Engineers, D. A. B. Miller 2008, Cambridge University Press
- Introductory Quantum Mechanics, Richard L. Liboff, Pearson Education, New Delhi.
- Quantum Mechanics, B.H. Bransden and C.J.Joachin, Pearson Education, New Delhi.

III. CORE COURSE [CCPHY103]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

SOLID STATE PHYSICS AND GENERAL ELECTRONICS

Theory: 60 Hours; Tutorial:15 Hours

Solid State Physics

Crystal Physics: Laue theory of X-ray diffraction, Geometrical structure factor and intensity of diffraction maxima. Calculation of structure factor for bcc, fcc and diamond structure, Intensity of diffraction maxima, Extinction due to Lattice centering. **12 Lectures**

Electronic Properties: Electron in a Periodic lattice, Block Theorem, Band Theory, Tight Binding, Cellular and Pseudopotential method, Fermi surface, de Haas van Alphen Effect, Cyclotron resonance, Magnetoresistance, Quantum Hall Effect. **15 Lectures**

Magnetism: Exchange interaction, Heisenberg model and molecular field theory, spin waves and magnons, Ferri and Antiferromagnetic order, Domains and Bloch Wall energy. **10 Lectures**

Superconductivity: Basic properties of superconductors, Josephson Effect, BCS theory, High temperature superconductivity. **8 Lectures**

General Electronics

Microwave Components / Devices: Attenuators, phase shifters, directional couplers, T junction, Magic Tee, Standing wave detectors and cavity resonators (circular). Reflex klystron, TWT, Velocity modulation, Magnetron, Cavity Magnetron, Principle of operation of magnetrons in pi-mode and anode strapping. **15 Lectures**

Photonic Devices: Radiative and non-radiative transitions, optical absorption, bulk and thin film photoconductive devices (LDR), diode photo detectors, solar cell (open circuit voltage and short circuit current, fill factor), LED (high frequency limit, effect of surface and indirect recombination current, operation of LED), Blue LED, LEDs as commercial sources of lighting, diode lasers conditions for population inversion in active region, optical gain and threshold current for lasing. **15 Lectures**

Books Suggested:

- Kittel,C., “Solid-State Physics”,
- Arun Kumar, “Introduction to Solid State Physics”, PHI Learning
- Aschroft, N.W. and Mermin, N. D., “Solid-State Physics”
- Verma and Srivastava, Crystallography for Solid State Physics.
- A.A.Khan & K.K.Dey, A first course in Electronics, PHI
- Arun Kumar, Basic Electronics, BharatiBhawan
- S. O. Pillai, “Solid State Physics”, New Age International.
- Allen, Optoelectronics, Theory & Practical, McGraw Hill
- Pallabh Bhattacharya, Semiconductor Optoelectronics Devices, PHI
- Jordon & Balmain, Electromagnetic Waves & Radiating System, PHI
- Kulkarni, Microwave & Radar Engineering, Umesh Publication
- Optical Electronics, AjoyGhatak and K. Thyagarajan, Cambridge University Press.
- Dinesh C Dube, “Microwave Devices & Applications”, Narosa Publishing House.
- Chattopadhay & Rakshit. “Electronic Fundamentals and Applications”, New Age techno Press.

IV. CORE COURSE PRACTICAL [CPPHY104]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	Pass Marks =45

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL-I **Practical: 60Hours**

OPTICS, LASER PHYSICS LAB

1. Studies with Michelson's Interferrometer.
   (a) Determination of wavelength separation of sodium D-lines.
   (b) Determination of thickness of mica sheet.

2. Studies with Fabre-Perot Etalon.

3. Studies with Edser-Butler Plate.

4. Studies of phenomena with polarized light:
   (a) Verification of Brewster's law.
   (b) Verification of Fresnel's law of reflection of plane polarized light.
   (c) Analysis of elliptically polarized light using □/4 plate and Babinet's compensator.

5. Verification of Rayleigh's criterion for the limit of resolution of spectral lines using (a) prism spectrum and (b) grating spectrum.

6. Determination of optical constants of metal in thin film form.

7. Studies on Zeeman effect.

8. Young's modulus determination by optical method.

9. Experiments using He-Ne laser source:
   (a) Determination of laser parameters.
   (b) Measurement of the angle of a wedge plate using Heidinger fringes.
   (c) Determination of grating pitch using phenomena of self-imaging.
   (d) Determination of wavelength with a vernier caliper.

SEMESTER II 4 Papers

Total 100 x 4 = 400 Marks

I. CORE COURSE [CCPHY201]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	**Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

SPECTROSCOPY **Theory: 60 Hours; Tutorial:15 Hours**

Atomic Spectra: Space quantization, Relation between angular momentum and magnetic moment, Bohr magnetron. Fine structure of spectral lines, Term symbols of alkali and alkaline earth atoms. LS and JJ coupling. Quantum theory of Zeeman effect (normal and anamolous), Paschen-Back effect, Stark effect (linear and non-linear). Hyperfine structure of spectral lines, X-ray spectra characteristics and absorption. **15 Lectures**

The Rotation of the Molecule: Rotational spectra-Rigid diatomic molecule, The intensities of spectral lines, Effect of isotopic substitution, the non-rigid rotator, Simple harmonic oscillator, The an-harmonic oscillator, Diatomic vibrating rotator, Born Oppenheimer approximation, Techniques and instrumentation applications. **15 Lectures**

Molecular Spectra: Infrared and Raman spectra of diatomic molecules using an-harmonic oscillator, non-rigid rotator and vibrating rotator as models. Electronic states and electronic transitions in diatomic molecules, Frank Condon principle. **15 Lectures**

Resonance Spectroscopy: Nature of spinning particle, Interaction between spin and a magnetic field, Larmor Precession, Theory of NMR, Chemical shift-relaxation Mechanism, experimental study of NMR, Theory and experimental study of NQR, Theory of ESR, Hyperfine structure and fine structure of ESR, Experimental studies and applications, Mossbauer spectroscopy, Principle-Isomer shift, Quadrupole effect, effect of magnetic field, Instrumentation applications. **15 Lectures**

Laser and Holography: Spontaneous and stimulated emission, Einstein A and B coefficients, Basic Principles of Laser, Population Inversion-Two level and Three level Laser system, optical pumping-3+ rate equation, modes of resonator and coherence length, The Nd , YAG laser, The Neodymium Glass laser, The CO_2 Laser, Organic Dye lasers, Semi-conductor Laser, Liquid Laser. Principle of Holography, Theory-practical applications including data storage.

15 Lectures

Books Suggested:

- Kuhn, "Atomic Spectctra".
- Ghatak&Loknathan, "Quantum Mechanics".
- Herzberg, Spectra of diatomic molecules
- Elements of Spectroscopy: Gupta, Kumar and Sharma, PragatiPrakashan.
- Fundamentals of Molecular Spectroscopy: Colin and Elaine, TMH.
- Laser and Non-linear Optics: B.B.Laud, New Age Publications.

II. CORE COURSE [CCPHY202]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

QUANTUM MECHANICS -II

Theory: 60 Hours; Tutorial:15 Hours

Approximation Methods: The WKB approximation and its applications to one dimensional bound system and barrier penetration problem, The vibrational method (Ritz method) and its application to linear harmonic oscillator and helium atom, Stationary perturbation theory, non-degenerate and degenerate cases and applications to an-harmonic oscillator; linear Stark effect; Zeeman effect and spin-orbit coupling in the hydrogen atom. Time-dependent perturbation theory, constant perturbation and Fermi Golden rule, harmonic perturbation (Einstein's A and B co-efficient). **30 Lectures**

Theory of Scattering: Scattering amplitude and cross-section, Partial wave analysis, Born approximation and its validity with application to Rutherford's α-particle scattering. **10 Lectures**

Identical Particles: Many particle Schrodinger equation, The Indistinguishability principle, Symmetric and anti-symmetric wave functions, Pauli exclusion principle, Importance of symmetry character of wave function in the dynamics of bound system (helium atom), Hydrogen molecule (Heitler- London theory). **15 Lectures**

Relativistic Quantum Mechanics: Klein-Gordon equation for free particle, Dirac equation, Properties of Dirac matrices, Probability and current densities, Covariance of Dirac equation, Free particle solution and negative energy states, magnetic moment and spin of electron,
Dirac equation for central field, Energy states of the hydrogen atom. **15 Lectures**

Second Quantization: Number representation of fermions and bosons, Creation and annihilation operators, Electromagnetic field in vacuum. **05 Lectures**

Books Suggested:

- Thankappan, V.K., "Quantum Mechanics", Wiley Eastern
- Mathews, P.M., &Venkatesan, K., "A Text Book of Quantum Mechanics", TMH.
- Merzbacker, E., "Quantum Mechanics", John Wiley
- Messiah, A., "Quantum Mechanics", North-Holland Publishing Co.
- Schiff, L.I., "Quantum Mechanics", McGraw-Hill
- Ghatak, A., Quantum Mechanics", Narosa Publishing House, New Delhi.
- Agarwal, B. K., "Quantum Mechanics', PHI
- Landau, L.D. &Lifshitz, E.M., "Quantum Mechanics", Pergman Press
- Introduction to Quantum Mechanics by D. i. Griffiths. II Edn., pearson Education
- Also the books recommended earlier in Quantum Mechanics Course – I.

III. CORE COURSE [CCPHY203]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

NUCLEAR PHYSICS – I **Theory: 60 Hours; Tutorial:15Hours**

Nuclear Radiation Detectors
Detection: Simple model of of detector, energy measurement, position and time measurement.
Solid State Detectors: Semiconductor detectors, Surface barrier detectors, Scintillation counters: Organic and inorganic scintillators, Photomultiplier tubes, Gamma Ray Scintillation Spectrometer.
High Energy Particle Detectors: General principles, Nuclear emulsions, Cloud chambers, Bubble chamber.
Nuclear Electronics: Pulse shaping, Linear amplifiers, Pulse height discriminators, Single channel and Multichannel analyzer. **25 Lectures**

Nuclear Reactor Theory
Fundamentals of Nuclear Fission: Fission fuels, Prompt and delayed neutrons, Chain reaction, Multiplication factor, Condition for criticality, Breading phenomena.
Diffusion of neutrons: Neutron current density, The equation of continuity, Fick's law, The diffusion equation, Measurement of diffusion parameters. **15 Lectures**

Neutron Moderation: Moderation without absorption, Energy loss in elastic collisions, Average logarithmic energy decrement, slowing down power and moderating ratio of a medium. Slowing down densities, Moderation- Space dependent slowing down, Fermi's age theory, Moderation with absorption **15 Lectures**

Criticality of an Infinite Homogenous Reactor: The critical equation, Optimum reactor shapes, Material and geometrical bucklings, Neutron balance in a thermal reactor, Four factor formula, Calculation of critical size and composition in simple cases. **15 Lectures**

Power Reactor: Fast breeder reactors, Thermo-nuclear reaction, nuclear fusion in stars, Concept of fusion reactor. **05 Lectures**

Books Suggested:

- Segre, E., “Experimental Nuclear Physics”, John Wiley
- Singru, R.M., “Introduction to Experimental Nuclear Physics”, John Wiley & Sons, 1974.
- W.R. Leo, “Techniques for Nuclear and Particle Physics Experiments”
- Kapoor S.S and Ramamurthy V.S., “Nuclear Radiation Detectors”, New Age International Publishers 1986.
- Syed Naeem Ahmed , “Physics and Engineering of Radiation Detection”, Academic Press, Elsevier, 2007.
- Glasstone, S. and Edlund, M. C., “The Elements of Nuclear Reactor Theory”, Van Nostrand Co., 1953.
- Stacey, W. M., “Nuclear Reactor Physics”
- Lamarsh, J. R., “Introduction to Nuclear Reactor Theory’, Addison Wesley, 1966
- Murray, L., “Introductions of Nuclear Engineering”.
- Varma, J. “NUCLEAR Physics Experiments”, New Age International Publishers 2001.
- Singru, R.M., “Introduction to Experimental Nuclear Physics” Wiley Eastern Pvt. Ltd.

IV. CORE COURSE PRACTICAL [CPPHY204]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	**Pass Marks =45**

Instruction to Question Setter:
End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL-II **Practical: 60Hours**

GENERAL ELECTRONICS AND ATOMIC & NUCLEAR PHYSICS LAB

1. 'e/m' measurement by Braun's tube and by Magnetron valve method.
2. 'e' measurement by Millikan oil drop apparatus.
3. Design and characteristics of passive attenuators (T- and π-types)
4. BJT based voltage amplifier: design and performance study with and without negative feedback.
5. JFET based voltage amplifier: design and performance study.
6. Half- and Full wave rectifier with and without filters
7. Series and shunt voltage regulators using Zener diode.
8. Verification of Truth table of Logic circuit using NAND gates and its DC characteristics.
9. Characterization of Photo –resister.
10. Determine the plateau characteristics of the given GM counter.
11. Verification of Inverse Square Law for Gamma-rays.
12. To measure the absorption coefficient of gamma rays in Aluminum or Copper.
13. To plot the Gaussian or normal distribution curve for background radiation.
14. Determination of dead time of the GM Counter.

SEMESTER III 4Papers

Total 100 x 4 = 400 Marks

I. ABILITY ENHANCEMENT COURSE [ECPHY301A]: (Credits: Theory-05)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	**Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
Paper ECPHY301 will have no theory mid-sem examination, but there will be a Practical session assessment of 30 marks. In this paper break-up of 20 (mid-semester examination) + 5(Assignment) + 5(overall performance) will not be applicable.

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

NUMERICAL METHODS AND SIMULATION

Theory: 60 Hours; Tutorial:15 Hours

Solution of Linear System: Numerical solution of algebraic equation, Iteration, Newton Raphson method, Solution of Linear system, Direct method, Gauss, Gauss-Jordon elimination method, Matrix inverstion and LU decomposition, Eigenvalues and Eigenvectors, Applications. **10 Lectures**

Interpolation, Lograngeapplroximation, Newton and Chebyshev Polynomials, Least square fitting, Application in some physical problems. **10 Lectures**

Numerical Differentiation and Integration: Numerical solution of ordinary differential equation, Iteration method, Picards method, Euler's method and improved Euiler's method. Introduction to quadrature, trapezoidal and Simpson's rule Applications. **10 Lectures**

Numerical Solution of Partial Differential Equations: First and second order, Linear and non-linear differential equations, Solution by method of iteration, Euler and Runge Kutta methods. Finite difference method, Relaxation, Fourier and cyclic reduction and the
Rayleigh-Ritz method, Application to diffusion of dopant in a semiconductor, Wave equation in a coaxial cable, Vibrating strings and membranes, Poison equation, Schrodinger equations.
15 Lectures

Monte Carlo Technique: Evaluation of single and multi-dimensional integrals, Optomization problems, Applications to statistical mechanics, Metropolis algorithm. **05 Lectures**

Simulation/ Modeling: Concept of modeling, Introduction to techniques of modeling, State variable model of system, Model parameters and simulation using SCILAB / MATLAB / SIMULINK, Time domain and frequency domain analysis of systems using SCIL:AB / MATLAB, Spice modeling

of semiconductor devices (pn diode and BJT) and programming methodology, Circuit simulation using PSpice / LabView / ORCAD **10 Lectures**

Basic programming concepts using Scilab / Matlab to solve the problems based on the following: 15 Sessions

1. Interpolation and extrapolation: Least Square Fitting.
2. Solution of simultaneous equation: Polynomial equation, Polynomial equation fitting.
3. Matrix manipulations, Matrix inversion, Eigenvalues computations.
4. Numerical integration and differentiation.
5. Ordinary boundary-value problems, Two dimensional problems.
6. Monte Carlo method and its applications, Evaluation of two and three dimensional integrals.

Books Suggested:

- Introduction to Numerical Analysis, S.S. Sastry, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++., J. Hubbard, MCGraw-Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing W.H Pressetal, Cambridge University Press.
- A First Course in Numerical Methods, U.M Ascher& C. Greif, PHI Learning.
- Elementry Numerical Analysis, K.E.Atkinson, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, Courier Dover Pub.
- An Introduction to Computational Physics, T. Pang, Cambridge Univ.
- Simulation of ODE/PDE Models with Matlab® , Octave and Scilab, Scientific and Engineering Applications: A.V. Wouwer, P.Saucez, C.V.Fernandez. 2014 Springer.
- Scilab by Example: M. Affouf 2012, ISBN: 978-1479203444.
- Scilab (A free Software to Matlab): H.Ramchandran, A.S. Nair. 2011, S.Chand& Company.
- Scilab Image Processing, Lamberr M.Surhone, 2010 Betascript Publishing.

OR

SKILL ENHANCEMENT COURSE [ECPHY301B]: (Credits: Theory-05)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
Paper ECPHY301 will have no theory mid-sem examination, but there will be a Practical session assessment of 30 marks. In this paper break-up of 20 (mid-semester examination) + 5(Assignment) + 5(overall performance) will not be applicable.

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

EXPERIMENTAL TECHNIQUES **Theory: 60 Hours; Practical:15 Sessions**

Sensors: Characteristics, Sensitivity, reproducibility, Sensors for displacement, Velocity, acceleration, Strain, Temperature, Pressure, Magnetic field. **05 Lectures**

Thin Film Coating: Evaporative coating, DC and plasma sputtering, Laser ablation techniques for measuring thickness of thin film. **08 Lectures**

Low Temperatures Techniques: Properties of cryogenic fluids, bath cryostat and continuous flow cryostat, Cryogenic refrigerators, Temperature measurements, a Cryostat for resistivity measurement. **08 Lectures**

High Pressure Techniques: High pressure cell for resistivity measurement, Measurement of high pressure, Diamond anvil cell for very high pressure. **08 Lectures**

Spectroscopic Techniques: IR absorption to study molecular vibrations and rotations, band gap of semiconductors, superconducting energy gap, Visible and UV absorption for the study of electric energy levels, defects in solids etc. Raman effect for the study of molecular vibrations and vibrations in solids, Main components of spectrometers, Sources, Dispersing element and detector, IR, UV, Visible absorption spectra, Description of Raman spectrometer and Raman spectra. **08 Lectures**

NMR and EPR Spectrometers: Principle of operation, Basic components of the spectrometer, Typical NMR and EPR spectra and applications. **08 Lectures**

X-ray Diffraction Techniques and Electron Microscope: Principle of x-ray diffraction, Bragg's law and Laue pattern, Powder diffraction method, Transmission and Scanning electron microscopes and applications. **08 Lectures**

Surface Probe Techniques: Principle of AFM, STM, MFM and applications. **07 Lectures**
Lab Work for this Course: Fabrication of thin film using evaporation and sputtering technique, Raman spectra analysis if a sample, Study of EPR and NMR spectra, Study of X-ray diffraction pattern of powder sample, SEM photograph studies **15 Sessions**

Books Suggested:

- Molecular Spectroscopy, An Introduction, Jagmohan, Narosa Publication.
- Advanced level Physics Practical, Michael Nelson and Jon M.Ogborn, 4th Edn, Reprint 1985, Heinemann Educational Publishers.
- Advanced Practical Physics for Students, B.L.Flint & H.T. Worsnop, 1971, Asia Publishing.
- Introduction to Measurement and Instrumentation, A.K.Ghosh, 3rd Edn., PHI Learning Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edn. 2011, Kitab Mahal, New Delhi.
- Measurement, Instrumentation and Experiment Design in Physics & Engineering, M.Sayer, and A.Mansingh, 2005, PHI Learning.

IV. CORE COURSE [CCPHY302]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

STATISTICAL PHYSICS Theory: 60 Hours; Tutorial:15 Hours

Quantum Ensemble Theory: Micro-canonical Canonical and Grand Canonical ensembles, Phase space, Distribution functions, Partition function and relationship to thermodynamic quantities, Fluctuations in energy, particle density, Pressure and volume, Equivalence of ensembles.
12 Lectures

Quantum Statistics: Equation of state of ideal Fermi and Bose gases, Degenerate electron gas and specific heat, Degenerate Bose gas, Bose-Einstein condensation, Evaluation of constant α and β and its thermodynamics interpretation, Thermal properties of Bose- Einstein and liquid He 4, the Lambda transition, two fluid model, Black body distribution law.Density matrix and classical limit for N-particles partition function. **16 Lectures**

Imperfect Gases: Classical and Quantum cluster expansion, Virial equation of state, Virial coefficients in classical limit, Second Virial coefficients for hard-sphere and square-well potentials.
10 Lectures

Phase Transitions: Ising model, Bragg-Williums Approximation, Mean field theories of the Ising model In three, two and one dimensions, Exact solutions in one dimension, Landau theory of phase transition, Critical indices, Scale transformation and dimensional analysis. **12 Lectures**

High-Density Gases: Thermo-ionic and photoelectric emission, Spin Para-magnetism, Landau Diamagnetism, Equation of state at very high density, Equilibrium of bodies of large mass, Chandrasekhar mass limit, White dwarf and neutron stars. **10 Lectures**

Non-Equilibrium Statistical Mechanics: Boltzman Transport equation, Boltzman H-theorem, Equations of motion in classical mechanics, Time correlation function, Linear response theory, Electrical conduction, Langevin's equation and Brownian motion, Debye theory of dielectric relaxation. Motion due to fluctuating force. The Fokker-Planck Equation, Solution on Fokker-Planck Equation. **15 Lectures**

Books Suggested:

- Sinha, S.K., “Statistical Mechanics”,
- Kerson & Huang, “Statistical Mechanics”,
- Friedman, H.L., “A Course in Statistical Mechanics”,
- McQuarrie, D.A., “Statistical Mechanics”,
- Landau, L, &Liefshitz, “Statistical Mechanics”, Pergaman Press.
- Statistical Mechanics, R.K.Patharia, Bufferworgh Heinemann
- Fundamental of Statistical and Thermal Physics, F.Rief, McGraw Hill International Edition.
- Fundamental of Statistical Mechanics, B.B. Laud, New Age International Pub.
- R.K.Srivastava & J.Ashok, “Statistical Mechanics”.
- Hill, T.L., “Statistical Mechanics”,
- Gupta & Kumar, “Statistical Mechanics”,
- Agrawal, B.K., Statistical Mechanics.
- Prakash Satya & Agrawal J.P., “Thermodynamics Statistical Physics & Kinetics”

V. CORE COURSE [CCPHY303]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:
Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

NUCLEAR PHYSICS –II **Theory: 60 Hours; Tutorial: 15 Hours**

Fundamental Properties of Nuclei: Electric moments and magnetic moments of nucleous, Measurement of magnetic moment of neutron, proton and nuclear magnetic moments, Parity and statics of nucleus, i-spin formalism. **15 Lectures**

Two-Nucleon Forces: Theory of ground state of the deuteron, Partial wave analysis of low energy n-p and p-p scattering, Effective range theory of low energy n-p and p-p scattering, Coherent n-p scattering and spin dependence of nuclear force, Exchange forces and tensor forces, Meson theory of nuclear force,Yukawa interaction, Charge independence and charge symmetry of nuclear forces. **15 Lectures**

Nuclear Structure (models): Single particle shell model and its successes, Semi-empirical formula of Weizsaker energy, β-activity of isobars, Liquid-drop model and Bohr-Wheeler theory of fission, Collective model of Bohr and Mottelson. **15 Lectures**

Nuclear Interactions and Nuclear Reactions: Compound nucleus theory, Resonance reaction, Breit Wigner dispersion formula for *l=0* neutrons, Weak interaction-phenomenon of β-decay; Fermi's theory; selection rules for β transition; parity non-conservation in β decay. Experimental demonstration. **15 Lectures**

Particle Physics: Fundamental interactions, Conservation laws, Discrete symmetries - parity; charge conjugation and time reversal; G parity and CPT theorem, Internal symmetries -Isospin formalism; SU2 and SU3 groups and their applications to multiplet mesons and baryons; Quark model -Gell Mann - Okubo mass formula for octet and decuplet hadrons - charm, bottom and top quarks, Gluons as mediators of strong interaction. **15 Lectures**

Books Suggested:

- Introductory nuclear Physics by Kenneth S. Krane, Wiley India Pvt. Ltd., 2008.
- Concepts of nuclear physics by Bernard L. Cohen, Tata Mcgraw Hill, 1998.
- Introduction to Elementary Particles by D. Griffith, John Wiley & Sons
- Introductory Nuclear Physics by S.S.M. Wong, PHI
- Theoretical Nuclear Physics by J.M. Blatt, & V.F. Weisskoff, John Wiley
- Introduction to Nuclear Physics by H.A. Enge, Addison Wesley
- Nuclear Physics by R.R. Roy, &B.P.Nigam, John Wiley
- Introductory Nuclear Theory by L.R.B Elton, Sir Isaac Pitman & Sons Ltd.
- Physics of the Nucleus byM.A. Preston, Addison Wesley
- Quarks and Leptons by F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach byK. Heyde (IOP- Institute of Physics Publishing, 2004).
- Introduction to the physics of nuclei & particles by R.A. Dunlap. Thomson Asia, 2004.
- The Atomic Nucleus by R.D. Evans, TMH

IV. CORE COURSE PRACTICAL [CPPHY304]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	Pass Marks =45

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto60%, 1mark; 60<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL-III **Practical: 60Hours**

GENERAL EXPERIMENTAL LAB

1. Frank Hertz Experiment.
2. Experiment with Hall apparatus.
3. Four-Probe set up for mapping the resistivity of large sample.
4. Measurement of magneto resistance of semiconductor sample.
5. Measurement of Susceptibility of paramagnetic solution by Quinke's tube method.
6. Study of the energy band gap and diffusion potential of p-n junction.
7. Study of Multi-vibrator.
8. Study of Characteristics of Semiconductor diodes: Si, Ge, Zener and LED.
9. Study of an Integrated Circuit Regulator.
10. Two Probe method for resistivity measurement of insulators at different temperatures

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SEMESTER IV 4 Papers

Total 100 x 4 = 400 Marks

I. GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECPHY401A]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

NANOPHYSICS AND NANOMATERIALS – I

Theory: 60 Hours; Tutorial: 15 Hours

Nanophysics: Introduction to nanophysics and quantum size effect, Dimensionalities and density of states, Optical and transport properties of two-dimensional electron gas formed at heterostructures and within novel grapheme monolayers with internal folds, Quantum Hall effects, Physics of one-dimensional electron systems including carbon nanotubes and semiconductor nanowires, Fundamental Physics of zero-dimensional electron system, Single electron effects, Quantum dots and nanocrystals, Fundamental principles and applications of scanning tunneling microscopy in the study of nanophysics. **25 Lectures**

Synthesis of Nanomaterials: Top down and Bottom up approach, Synthetic procedures and their significance, Types of nanomaterials synthesis processes, ROHS and WEEE guideness, Physics method, Photolithography, Advanced Ceramics (Solid State reaction method), Ball milling method, Chemical method, Co-precipitation technique, So-gel method, Soft chemical technique (citrate tertarate, etc.), Hydrothermal method, Bio-chemical method, Thin film technology, Thermal Evaporation method, Sputtering (RF and DC), Spray pyrolysis method, Spin coating method, Pulsed laser deposition method, Vaccum arc discharge, Chemical vapor deposition method (CVD), MOCVD, MBE, Ion beam deposition, Electron-beam lithography. MBE growth of quantum dots. **30 Lectures**

Characterization Technique: Introductory remarks, Structural, X-ray and neutron diffraction, XPS, Electron beam techniques, Scanning Electron Microscope, Transmission Electron Microscope, Scanning Tunneling Microscope, Atomic Force Microscope, Photo luminescence Cathodo-luminescence, Electro-luminescence, UV-visible and Fourier transformed infrared spectrophotometry, Thermal analysis, Thermogravimetry analysis, Differential Scanning Calorimeter, Dielectric and Impedance analysis, Magnetic measurements. **20 Lectures**

Books Suggested:

- C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)
- S.K.Kulkarni, Nanotechnology, Principle & Practices (Capital Publishing Company).
- K.K.Chatopadhyay and A.N.Banerjee, Introduction to Nanoscience& Technology (PHI Learning Private Limited)
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
- M. Hosokawa, K. Nogi, M. Natia, T.Yokoyama, Nanoparticle Technology Hanbook (Elsevier, 2007)
- Bharat Bhushan, Springer Hanbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

OR

GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECPHY401B]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	**Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ELECTRONICS AND COMMUNICATION – I

Theory: 60 Hours; Tutorial: 15 Hours

Operational Amplifier: Operational amplifier (op amp) types, salient features, parameters and modeling, Voltage op amp based circuits such as:

- Instrumentation amplifier (IA)
- Negative impedance converter (NIC)
- Inductance simulation
- Precision rectification
- Active Butterworth low pass, high pass and band pass 2nd order filters
- Simulation of differential equations
- Analog multiplier and its use in integer power generation, frequency multiplication, divider and generation of fractional powers
- D/A and A/D converters **20 Lectures**

Current Conveyor: Current conveyor types, their salient features, modeling and simple applications in realizing bandwidth independent gain amplifier, Current conveyor based differentiator, integrator, adder and instrumentation amplifier, Advantages of current conveyor based circuits over the conventional voltage op amp based circuits. **08 Lectures**

BJT Logic Families: TTL logic NAND gate circuit, ECL logic OR/NOR gate circuit, analysis and evaluation of logic parameters. **08 Lectures**

MOS Logic Families: NMOS inverter circuit and its analysis with linear and non-linear loads, CMOS inverter. **06 Lectures**

Radar: Basic arrangement of radar system, Azimuth and range measurement, Operating characteristics of a radar system, Derivation of radar range equation. **08 Lectures**

Antenna: Antenna action, Short electric doublet, Linear array of n isotropic sources of equal amplitude and spacing, Broad-side array, Ordinary end-fire array, End fire array with increased directivity, Beam width of the main loab, Yagi antenna, Resonant and non-resonant array arrangement **15 Lectures**

Satellite Communication: Orbital and geostationary satellites, Orbital patterns, Look angles, Satellite system, Link modules. **10 Lectures**

Books Suggested:

- A first course in Electronics, A.A.Khan & K.K.Dey, Prentice Hall India.
- Basic Electronics, Arun Kumar, Bharati Bhawan
- Millman & Brabel, “Microelectronics”, McGraw-Hill (International Students’ Edition).
- Mitchell & Mitchell, “Introduction to Electronics Design”, Prentice-Hall of India.
- Nagrath, “Electronics: Analog and Digital”, Prentice-Hall of India.
- Soclof, “Design and Applications of Analog Integrated Circuits”, Prentice-Hall of India.
- Gayakwad, “Op-Amps and Linear Integrated Circuits”,3/e, Prentice-Hall of India
- Sedra& Smith, “Microelectronic Circuits”, 3/e, Sounders College Publishing.
- Microwave and Radar Engineering Kulkarni, Umesh Publication.
- Electromagnetic Waves and Radiating Systems: Jordan, PHI
- Hand Book of Electronics, Gupta & Kumar, Pragati Prakashan, Merrut.
- Electronics Communications: Roddy Coolen, PHI
- Electronic Communication: Kennedy & Davis, TMH

OR

GENERIC/ DISCIPLINE CENTRIC ELECTIVE [ECPHY401C]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	**Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

CONDENSED MATTER PHYSICS -I **Theory: 60 Hours; Tutorial: 15 Hours**

X-ray Diffraction Theory: Coherent and incoherent scattering, Derivation of Laue equations and expression for structure factor, Data reduction. **08 Lectures**

Crystal Structure Determination: The phase problem in crystallography, Electron density as Fourier transform of structure factor and vice versa, Techniques to solve the phase problem – Fourier and Patterson methods, Heavy atom technique, The Single Isomorphous Replacement (SIR) and Multiple Isomorphous Replacement (MIR) techniques, Anomalous scattering technique, Direct methods. **22 Lectures**

Experimental Techniques: The Weissenberg and Precession methods, The Diffractometer, Area Detector and Image Plate. **10 Lectures**

Fermi Surface: Construction of Fermi surface, Zone schemes, Electron, hole and open orbits, Cyclotron resonance. *Determination of Fermi surface* – Quantization of orbits in magnetic field; de-Hass – van-Alfen effect; External orbits; Outline of other methods. **10 Lectures**

Phonons: *Harmonic crystals,* Crystal potential; Harmonic and adiabatic approximations; Normal modes and phonons; Phonon spectrum by neutron scattering; Crystal momentum. *Anharmonic crystals,* Anharmonicity, Lattice thermal conductivity, Umklapp process; Second sound. **10 Lectures**

Magnetism: Interaction of solids with magnetic fields, Magnetization density and susceptibility, Calculation of atomic susceptibility, Susceptibility of insulators (Larmor diamagnetism), Ground state of ions with partially filled shells (Hund's rule), van Vleckpara magnetism, Curie laws for free ions and solids, Pauli paramagnetism, Conduction electron diamagnetism, Exchange interaction, Ferromagnetic domains, Anisotropy energy, Thickness and energy of Bloch walls, Ising model, Bragg-Williams approximation, Solution of Ising problem for a linear chain. **15 Lectures**

Books Suggested:

- Philips, “An Introduction to Crystallography”,
- Woolfson, M.M., “An Introduction to X-ray Crystallography”,
- International Tables for X-ray Crystallography, Vol. I
- Verma, A. R. & Krishna, P., “Polymorphism and Polytypism”,
- Kittel,C., “Solid-State Physics”,
- Raghavan, V., “Material Science and Engineering”.
- Aschroft, N.W. and Mermin, N. D., “Solid-State Physics”.
- Bunger, M.J., “Crystal Structure Analysis”.
- Bunger, M.J., “X-ray Crystallography”.
- Staut & Jenson, “A Practical Guide to X-ray Crystal Structure Determination”

II. GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECPHY402A]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

NANOPHYSICS AND NANOMATERIALS – II

Theory: 60 Hours; Tutorial: 15 Hours

Optical Properties: Coulomb interaction in nanostructures, Concept of dielectric constant for nanostructures and charging of nanostructure, Quasi-particles and excitons, Excitons in direct and indirect band gap semiconductor Nano-crystals, Quantitative treatment of quasi-particles and excitons, charging effects, Radiative processes, General formalization, absorption, emission and luminescence, Optical properties of hetero-structure and nanostructures. **20 Lectures**

Electron Transport: Electrical properties of Polymers, Ceramics, Dielectrics and Amorphous Materials, Electrical conduction in Metals, Alloys and Semiconductors, Band structure, Carrier transport in nanostructures, Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity, Defects and impurities, Deep level and surface defects. **20 Lectures**

Magnetic Properties of Materials: Classification of magnetic materials, Magnetic materials of technical importance, Magnetization processes, Superparamagnetism, Magnetic domain structure, Superconductivity, Phenomenology of superconductivity. **10 Lectures**

Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, Solar Cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices, Quantum dots hetero-structure lasers, optical switching and optical data storage. Magnetic quantum well, magnetic dots – magnetic data storage, Micro Electromechanical systems (NEMS), Nano, Electromechanical Systems (NEMS).Integrated optical devices, SQUIDS, Spintronic devices, Ferroelectric, Pyro-electric, Piezoelectric and electro-optic devices.
25 Lectures

Books Suggested:

SAME AS IN ECPHY401A

OR

GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECPHY402B]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	**Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:
Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ELECTRONICS AND COMMUNICATION – II

Theory: 60 Hours; Tutorial: 15 Hours

Transmission Line: Types of transmission line, distributed parameters, voltage and current relations on a radio frequency transmission line with respect to sending and receiving ends, propagation constant (γ), attenuation constant (α) and phase constant (β), expressions for α and β , transmission line distortion and attenuation, conditions for no distortion, low distortion and low loss, line termination across a short circuit, open circuit pure resistance and complex impedance, quarter wave and half wave lines and their impedance matching properties. **20 Lectures**

Wave Guide: Field expression for propagating TE and TM waves in hollow circular cylindrical wave guides, Impossibility of TEM waves in hollow wave guide, Attenuation in wave guides and Q-factor. **10 Lectures**

Fiber Optic Communication: Principle of light transmission in a fiber. Light sources for fiber optic communication, Effect of index profile on propagation, Modes of propagation, Number of modes a fiber may support, Single mode fiber (SMF),Losses in fibers. **15 Lectures**

Microprocessor Architecture: 8085 Microprocessor Architecture, Real Mode and protected modes of memory addressing, memory paging.
Addressing Modes: Data addressing modes, Program memory addressing modes, stack memory addressing modes.
Instruction Set: Data movement instructions, arithmetic and logic instructions, Program control instruction, Assembler details. **Interrupts:** Basic interrupt processing, Hardware interrupt. Expanding the interrupt structure 8259A PIC.
Direct Memory Access: Basic DMA operation, 8237 DMA controller, Shared Bus operation Disk Memory systems. **30 Lectures**

Books Suggested:

- Miah, "Fundamentals of Electromagnetic", TMH
- Mano, "Computer System Architecture", Prentice-Hall of India.
- Goankar, Microprocessors Architecture, Programming & Applications with 8085,
- Senior, "Optical Fiber Communications: Principles and Practice", 2/e, Prentice-Hall.
- Jordon &Balmain, "Electromagnetic waves and Radiating Systems", Prentice-Hall of India.

OR

GENERIC/ DISCIPLINE CENTRIC ELECTIVE [ECPHY402C]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Attendance/ regular interactions of 05 marks and (c) Seminar/ assignment of 05 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

CONDENSED MATTER PHYSICS -II **Theory: 60 Hours; Tutorial: 15 Hours**

I. **Phase Transformation and Diagrams**: phase rule, single component system, Binary phase system, lever rule, Nucleation and growth, Nucleation kinetics, Growth and overall transformation kinetics and applications to steel and glass **10 Lectures**

II. **ESR:** basic theory, relaxation mechanism, Effect of spin-orbit coupling and crystal fields on g values, Fine and hyperfine structures, Ferromagnetic resonance (FMR), General features of FMR, Shape effect in FMR, Antiferromagnetic resonance. **10 Lectures**

III. **NMR:** Basic theory, Spin lattice relaxation, Bloch equation and their steady state solutions, General features of NMR spectra, Chemical shifts, Fine structure due to spin-spin coupling, Application to molecular structure and bondings. **10 lectures**

IV. **Superconductivity**: BCS theory of superconductivity, Cooper pairs, superconducting ground state, Flux quantization in superconducting ring, Quasi-particles and energy gaps, Temperature dependence of energy gaps, London equation, Coherence length, Persistent current, Single particle tunneling, Josephson tunneling, Josephson effects (AC and DC), Microscopic quantum interference, Qualitative idea of high temperature superconductors, Critical fields and moments. **15 Lectures**

V. **Thin Films:** Deposition techniques, thermal, electron and sputtering methods, metallic semiconductor and insulator thin films and their electrical, electronic and optical properties. Magnetic superconducting thin films and applications. **15 Lectures**

VI. **Dielectrics:** Structure of dielectrics, Polarization mechanism, Effect of temperature and frequency. Effect of conduction (ionic and electronic) in dielectrics, Dielectric losses and breakdown, Electrets and MIM. **15 Lectures**

Books Suggested:

- Crystallography - Philips
- Solid State chernistry-Garner (Butterworth; London)
- Solid State Chemistry -D.K.Chakraborty (New Age int Publication)
- Solid State Chemistry- N. BHannay (Prentice Hall, New Jersay)
- Physical Chemistry- Waller J. Moore
- Principles of polymer chemistry Cornell , P. J. Flory (Univ. Press)
- Handbook of Conducting Polymers Vol I & II" T A. Skolhia

III. GE/DC PRACTICAL [EPPHY403A]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	**Pass Marks =45**

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL –IV

NANOPHYSICS AND NANOMATERIALS

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticle.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

OR

GE/DC PRACTICAL [EPPHY403B]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	**Pass Marks =45**

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL –IV

ELECTRONICS AND COMMUNICATION LAB

1. Operational amplifier parameters measurements and their dependence on frequency.
2. Basic operational amplifier configurations: inverting amplifier, non-inverting amplifier, voltage follower, differentiator, integrator and instrumentation amplifier.
3. Butterworth second order active low pass and high pass filters.
4. Studies on second order band-pass and band-elimination active filters.
5. Design and study of Wein bridge oscillator circuit.
6. Design and study of op amp based square wave oscillator.
7. To draw the characteristic curve of SCR and to determine its holding voltage, holding current and break-over voltage
8. Use of IC 555 timer.
9. To simulate electronic circuits using PSpice.
10. BCD adder and subtractor.
11. Precision rectification: half- and full- wave.
12. DIAC and TRIAC characteristics and applications.
13. Studies on the polar pattern of microwave transmitting horn antenna.
14. Familiarity with microwave components, microwave propagation in hollow rectangular wave-guide and measurement of dielectric constant in X-band.
15. Amplitude modulation and demodulation.
16. Studies on Phase Locked Loop (PLL) IC 565 and its use in frequency multiplication.
17. Design, construct and test electronically regulated power supplies using Zener diode, 3-pin regulators (78xx/79xx) and IC 723.
18. Design and study of the characteristics of TTL logic NAND gate and the evaluation of its parameters.

OR

GE/DC PRACTICAL [EPPHY403C]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	**Pass Marks =45**

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL –IV

CONDENSED MATTER PHYSICS LAB

1. Studies on semiconductors: 4-Probe method for the determination of band gap and the dependence of resistivity on temperature.
2. Hall Effect study: Hall co-efficient, carrier concentration and carrier mobility.
3. Electrical properties of thin film samples.
4. ESR study.
5. Determination of magnetic parameters of some minerals using hysteresis loop tracer.
6. Crystal structure analysis using 3D – X-ray diffraction data (Data supplied).
   (a) Use of heavy atom technique.
   (b) Use of Direct Methods.
   (c) Computation of 3 –D Fourier and its interpretation.
   (d) Computation of Bond length, bond angle and H-bond & other geometrical parameters of known structures.
   (e) ORTEP plot of molecule.
7. Determination of polarazibality of sugar solution.
8. Determination of magnetic susceptibility using Guoy's method.
9. Determination of Curie temperature by dielectric constant apparatus.
10. Determination of modulus of rigidity and internal friction by modulus of rigidity apparatus.
11. Study of impedance spectrometry of a given sample using LCR meter.
12. Study of temperature dependence of Hall coefficient.
13. Synthesis of materials under different stoichiometric ratio.
14. Study of absorption pattern of a given sample using FTIR spectrometer.

VI. CORE COURSE (PROJECT) [PRPHY404]: (Credits: 05)

Marks : 100 (ESE: 3Hrs)=100	Pass Marks =45

Guidelines to Examiners for

End Semester Examination (ESE):

Overall project dissertation may be evaluated under the following heads:

- *Motivation for the choice of topic*
- *Project dissertation design*
- *Methodology and Content depth*
- *Results and Discussion*
- *Future Scope & References*
- *Participation in Internship programme with reputed organization*
- *Application of Research technique in Data collection*
- *Report Presentation*
- *Presentation style*
- *Viva-voce*

PROJECT WORK

Each student **must** submit two copies of the dissertation work duly forwarded by the **Head of the Department and duly signed by the supervisor concerned.** The forwarded copies will be submitted in the Department of Physics, Ranchi University, for evaluation (Seven days before the seminar).

The paper will consist of

(a) Field work/Lab work related to the project.

(b) Preparation of dissertation based on the work undertaken.

(c) Presentation of project work in the seminar on the assigned topic in the P.G. Department of Physics, Ranchi University, Ranchi & open viva there on.

Topics

Each students shall have to complete a project work on any topic of his choice, but relevant to the frontier area of Science and Technology, or on a topic allotted by his/her Project Guide/Supervisor/Department in Semester -IV. This is compulsory and the candidates shall ensure that his project is on a relevant topic completed by him independently with the help and inputs from his/her guide/supervisor. Other guidelines pertaining to this paper shall be provided by the department.

NB:- Students will select topics for the project work in consultation with a teacher of the department. The Seminar will be held in the Department of Physics, Ranchi University, Ranchi.

DISTRIBUTION OF CREDITS FOR P.G. PROGRAMME (SEMESTER-WISE) FOR POSTGRADUATE **'P.G. Voc./M.Sc./M.A./M.Com'** PROGRAMME

Table B-1: Semester wise distribution of 80 Credits for Subjects with Practical Papers.

Semester	CC	FC	GE/DC	AE	Total credits
Semester I	15	05			20
Semester II	20				20
Semester III	15			05	20
Semester IV	5		15		20
	55	**05**	**15**	**05**	**80**

Table B-1: Semester wise distribution of 80 Credits for Subjects without Practical Papers.

Semester	CC	FC	GE/DC	AE	Total credits
Semester I	15	05			20
Semester II	20				20
Semester III	15			05	20
Semester IV	10		10		20
	60	**05**	**10**	**05**	**80**

CC=Core Course; FC=Foundation Compulsory/Elective Course; GE=Generic Elective; SE=Skill Enhancement Course; DC=Discipline Centric Elective

SAMPLE CALCULATION FOR SGPA & CGPA FOR POSTGRADUATE **'P.G. Voc./M.Sc./M.A./M.Com'** PROGRAMME

Table B-2: Sample calculation for SGPA for M.Sc./M.A./M.Com Programme

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit X Grade)	SGPA (Credit Point/Credit)
Semester I					
FC	05	A	8	40	
C-1	05	B+	7	35	
C-2	05	B	6	30	
C-3/CP	05	B	6	30	
Total	**20**			**135**	**6.60 (135/20)**
Semester II					
C-4	05	B	6	30	
C-5	05	C	5	25	
C-6	05	B+	7	35	
C-7/CP	05	A+	9	45	
Total	**20**			**135**	**6.60 (135/20)**
Semester III					
EC-1	05	A+	9	45	
C-8	05	0	10	50	
C-9	05	A	8	40	
C-10/CP	05	A	8	40	
Total	**20**			**175**	**8.75 (175/20)**
Semester IV					
EC-2/EC-2	05	B	6	30	
EC-3/EC-3	05	A+	9	45	
C11/EP	05	B	6	30	
Project	05	A+	9	45	
Total	**20**			**150**	**7.50 (150/20)**
CGPA					
Grand Total	**80**			**595**	**7.44 (595/80)**

Table B-3: Sample calculation for CGPA for P.G. Vocational M.Sc./M.A./M.Com Programme

Semester I	Semester II	Semester III	Semester IV
Credit:20; SGPA:6.60	Credit:20; SGPA: 6.60	Credit:20; SGPA: 8.75	Credit:20; SGPA: 7.50

Thus CGPA= (20x6.60+20x6.60+20x8.75+20x7.50) /80**=7.36**

DISTRIBUTION OF MARKS FOR EXAMINATIONS AND FORMAT OF QUESTION PAPERS

Distribution of Marks for Mid Semester Evaluation:

Table No. 15: Distribution of marks of Theory Examinations of Mid Semester

Topic	Code	Full Marks	Pass Marks	Time	Group-A (Very short answer type Compulsory Questions) No. of Questions x Marks = F.M.	Group-B (Descriptive Questions) No. of Questions x Marks = F.M.	Total No. of Questions to Set	
							Group A	Group B
Mid Sem*	T30*	30 (20 +5 +5)	17	1 Hr	5 x1 =5	3 (out of 5) x5 =15	05	5

***There shall be 20 marks theory examination for mid sem, 05 marks for attendance/ regular interactions & 05 marks for seminar/ assignment/ term paper given by faculty concerned in classrooms.**

Distribution of Marks for End Semester Theory Examinations:

Table No. 16: Marks distribution of Theory Examinations of End Semester

Topic	Code	Full Marks	Pass Marks	Time	Group-A# (Very short answer type Compulsory Questions) No. of Questions x Marks = F.M.	Group-B (Descriptive Questions) No. of Questions x Marks = F.M.	Total No. of Questions to Set	
							Group A#	Group B
End Sem	T50	50	--	3 Hrs	2 x5 =10	2 (out of 3) x20 =40	2	3
	T70	70	28	3 Hrs	Q.No.1 (5x1) + 1x5 =10	4 (out of 6) x15 =60	2	6

 # Question No.1 in Group-A carries very short answer type questions of 1 Mark

Note : There may be subdivisions in each question asked in Theory Examinations.

FORMAT OF QUESTION PAPER FOR MID SEM EXAMINATION

20 MARKS

Ranchi University, Ranchi

Mid Sem No. Exam Year

Subject/ Code

F.M. =20 **Time**=1Hr.

General Instructions:
समान्य निर्देश :

i. **Group A** carries very short answer type compulsory questions.
(खंड 'A' में अत्यंत लघु उत्तरीय अनिवार्य प्रश्न हैं।)
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के पाँच में से किन्हीं तीन विषयनिष्ठ/ वर्णनात्मक प्रश्नों के उत्तर दें।)
iii. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
iv. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
v. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

1. ..... [5x1=5]
2. .....
3. .....
4. .....
5. .....

Group B

6. ..... [5]
7. ..... [5]
8. ..... [5]
9. ..... [5]
10. ..... [5]

Note: There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

50 MARKS

Ranchi University, Ranchi

End Sem No. Exam Year

Subject/ Code

F.M. =50

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 2 out of 3** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के तीन में से किन्हीं दो विषयनिष्ठ / वर्णनात्मक प्रश्नों के उत्तर दें।)
iii. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
iv. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
v. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

1. ..... [5]
2. ..... [5]

Group B

3. ..... [20]
4. ..... [20]
5. ..... [20]

Note: There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

70 MARKS

Ranchi University, Ranchi

End Sem No. Exam Year

Subject/ Code

F.M. =70 **P.M.**=28 **Time**=3Hrs.

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के छः में से किन्हीं चार विषयनिष्ठ / वर्णनात्मक प्रश्नों के उत्तर दें।)
iii. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
iv. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
v. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

1. [5x1=5]

i. .....
ii. .....
iii. .....
iv. .....
v. .....

2. ..... [5]

Group B

3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.