Syllabus for
Master of Science in Physics
Under Choice Based Credit System

Academic Session:
w.e.f. 2020-2022(onwards)

Binod Bihari Mahto Koyalanchal University, Dhanbad

Members of Board of Studies of CBCS Post-Graduate Syllabus as per Guidelines of the Binod Bihari Mahto Koyalanchal University, Dhanbad

1.Dr. K. Bandyopadhyay , Head, University Department of Physics, BBMK University, Dhanbad - Chairman

2.External expert members

i) Professor (Dr.) A. A. Khan (Retd.), University Department of Physics, Ranchi University, Ranchi

ii) Professor (Dr.) S. N. Singh, University Department of Physics, Ranchi University, Ranchi

3.Members

i) Dr. D. K. Giri, University Department of Physics, BBMK University, Dhanbad

ii) Dr. D. K. Singh, Department of Physics, PKRM College, Dhanbad

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COURSE STUCTURE

Semester Wise Examination/Course Structure for Science Faculty

Semester	Paper Code (Credit, Lectures)	Paper Name	Full Marks	End Semester Marks	Mid Semester (Internal) Marks (Written 20 marks) + Day to Day assessment includes extracurricular activities (5 marks) + Attendance (5 marks)
I	PHY-F-101 (5 Credits, 60 Lectures + 15 Tutorials)	Foundation	100	70	30
	PHY-C-102 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	PHY-C-103 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	PHY-C/P-104 (5 Credits, 75x2 Lectures)	Practical	100	70	30
II	PHY-S-205 (5 Credits, 60 Lectures + 15 Tutorials)	Skill Development Course (SEC)	100	70	30
	PHY-C-206 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	PHY-C-207 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	PHY-C/P-208 (5 Credits, 75x2 Lectures)	Practical	100	70	30
III	PHY-A-309 (5 Credits, 60 Lectures + 15 Tutorials)	Open Elective	100	70	30
	PHY-C-310 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	PHY-C-311 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	PHY-C/P-312 (5 Credits, 75x2 Lectures)	Core/ Practical	100	70	30
IV	PHY-E-413A/ PHY-E-413B/ PHY-E-413C	Discipline Centric Elective Theory A: B:	100	70	30

	(5 Credits, 60 Lectures + 15 Tutorials)	C:			
	PHY-E-414A/ PHY-E-414B/ PHY-E-414C (5 Credits, 60 Lectures + 15 Tutorials)	Discipline Centric Elective Theory A: B: C:	100	70	30
	PHY-E/P-415A/ PHY-E/P-415B/ PHY-E/P-415C (5 Credits, 75x2 Lectures)	Discipline Centric Elective Practical A: B: C:	100	70	30
	PHY-D-416* (5 Credits, 150 Lectures)	Dissertation/ Project	100	70	30
		Total Marks	**1600**	**1120**	**480**

or

Semester Wise Examination/Course Structure for Arts & Commerce Faculty

Semester	Paper Code (Credit, Lectures)	Paper Name	Full Marks	End Semester Marks	Mid Semester (Internal) Marks (Written 20 marks) + Day to Day assessment includes extracurricular activities (5 marks) + Attendance (5 marks)
I	XYZ-F-101 (5 Credits, 60 Lectures + 15 Tutorials)	Foundation	100	70	30
	XYZ-C-102 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	XYZ-C-103 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	XYZ-C-104 (5 Credits, 60 Lectures + 15 Tutorials)/	Core	100	70	30
II	XYZ-S-205 (5 Credits, 60 Lectures + 15 Tutorials)	Skill Development Course (SEC)	100	70	30
	XYZ-C-206 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30

	XYZ-C-207 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	XYZ-C-208 (5 Credits, 60 Lectures + 15 Tutorials)/	Core	100	70	30
III	XYZ-A-309 (5 Credits, 60 Lectures + 15 Tutorials)	Open Elective	100	70	30
	XYZ-C-310 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	XYZ-C-311 (5 Credits, 60 Lectures + 15 Tutorials)	Core	100	70	30
	XYZ-C-312 (5 Credits, 60 Lectures + 15 Tutorials)/	Core	100	70	30
IV	XYZ-E-413A/ XYZ-E-413B/ XYZ-E-413C (5 Credits, 60 Lectures + 15 Tutorials)	Discipline Centric Elective Theory A: B: C:	100	70	30
	XYZE-414A/ XYZE-414B/ XYZE-414C (5 Credits, 60 Lectures + 15 Tutorials)	Discipline Centric Elective Theory A: B: C:	100	70	30
	XYZ-C-415 (5 Credits, 60 Lectures + 15 Tutorials)/	Core	100	70	30
	XYZ-D-416* (5 Credits, 150 Lectures)	Dissertation/ Project	100	70	30
		Total Marks	**1600**	**1120**	**480**

Note: Symbol of Paper: **XYZ-F-101**: The first three symbols in Roman capital letters indicate the subject; the next symbol(s) denotes Foundation (F), Core (C), Discipline Centric Elective (E), AECC/SEC (S), etc. Out of the next three digits, the first digit indicates the semester e.g. 1,2,3,4,5,6 for semester I, II, III, IV, V, VI respectively, and the next two digits indicate paper number. The last letter T or P indicates Theory or Practical.

***Dissertation/Project:** Evaluation of project dissertation work may be as per the following guidelines:

- **Mid-Semester/Internal Assessment Examination** = 30 marks **(Annexure-1)**
- **End Semester Examination:** Project model (if any) and the Project record notebook, Project presentation and viva-voce = 70 marks
  (Jointly conducted by One External & One Internal Examiners)

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

Note:

(a) 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 to the concerned Department of University, for evaluation.
The paper will consist of
- Field work/Lab work related to the project.
- Preparation of dissertation based on the work undertaken.
- Presentation of project work in the seminar on the assigned topic & open viva there on.

(b) Each student 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.

(c) Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular intervals.

(d) Students will select topics for the project work in consultation with a teacher of the Department. The Seminar will be held in the concerned Department of University.

Format of the Dissertation/Project:

The **Dissertation/Project** shall be presented with the following specifications:

(a) **Size of Paper**: A4. Dissertation/Project must be printed on one side of the paper.

(b) **Font Type**: Times New Roman/Arial for English and Kruti Dev 010 for Hindi.

(c) **Font Size**: Font size for English text is 12pt. in standard form and for Hindi is 14pt.

(d) **Font of Chapter Headings and Sub-Headings**:

- Chapter headings may be written in all Capitals, bold text in point size 15
- Sub-headings are written with left margin alignment
- First level sub-headings are written in normal sentence case using bold text in point size 14
- Second level sub-headings are point size 13

(e) **Spacing and Paragraphing**:

- Printing shall be in standardised form with 1.5 line spacing
- Leave as triple spacing (2 empty lines) in base point size 12 before and after sub-headings and one empty line after all sub-headings
- Use one empty line between left-justified paragraphs

(f) **Margin**: Left margin should be 4cms and right and top margin should be 2cms. Bottom margins should be 2.5cms. No ornamental bordering of sides is permitted.

(g) **Page Numbering**: Preliminary pages of the **Dissertation/Project**, i.e. those preceding in text are to be numbered in Roman numbered. Text should be numbered in Arabic beginning with Pg No 1 on the first page of chapter 1.

(h) Preliminary sections of the **Dissertation/Project** should include, Declaration of Attendance**,** Certificate from Supervisor**,** Declaration by Candidate and Supervisor regarding Plagiarism**,** Acknowledgement, Table of Contents, List of Tables, List of Figures/Diagrams, List of Abbreviations (if any) and an Abstract of the Dissertation/Project.

(i) **Referencing and Citation Style**: Citation i.e. a way of giving credit to individuals for their creative and intellectual works that you utilised to support your research, differs by faculty in the style of ordering, punctuating and formatting of name, date, page, work etc.

The referencing of work and Citation style in the Dissertation/Project submitted in **Faculty of Science and Social Science** will be in **American Psychological Association (APA) style (6th edition)**, for **Faculty of Humanities** except for the Indian Languages, format shall be **Modern Language Association (MLA) (8th edition)** and for **Medical Science**, it shall be **Vancouver style**.

Annexure - 1

Research Methodology (Common for All Faculties)

M.A./M.Sc./M.Com. Courses
Semester-IV
Paper Code: XYZ-D-416

Mid Semester Examination (MSE): There will be **two** groups of questions in written examinations of **30 marks.Group A is compulsory** and will contain ten questions of **multiple type questions** consisting of **1 mark** each. **Group B** will contain **descriptive type eight questions** of **five** marks each, out of which any **four** are to be answered.

Broad topics of the syllabus are as under:

Introduction of Research Methodology: Meaning of Research, Objectives of Research, Research Methods

Types of Research: Descriptive vs. Analytical Research, Applied vs. Fundamental Research, Quantitative vs. Qualitative Research, Conceptual vs. Empirical Research

Research Process: Basic Overview; Literature Review; Formulating the Research Problem, Hypothesis, Research Questions, Research Methodology

Data Collection: Primary and Secondary Data, Sampling Method, Observation Method, Interview Method, Questionnaires, Case Study Method, Historical Method, Processing and Analysis of Data, Interpretation of Data/Results, Conclusions/Findings.

Research Writing: Synopsis, Article/Research Paper, Research Project, Thesis, Dissertation, Book, Book-Review, Case Review, Criteria of Good Research, Plagiarism

Citation Style & Methods: MLA, APA, Foot Note, Text Note, End Note, Footnotes, Bibliography, References

Reference Books:

a) Best and Kahn, Research Methodology, PHI Limited.
b) Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.

Annexure - 2

Format of question Paper of Mid-Semester Theory Examination

Binod Bihari Mahto Koyalanchal University, Dhanbad

Mid-Semester Examination xxxx (Session: xxxx-xx)

Subject/Code:

Full Marks: 20 Pass Marks: 08 Time: 1.5 Hours

General Instructions:

Candidates are required to give their answers in their own words as far as practicable.

The Questions are of equal value.

Answer any five questions of the following in which Q.1 is compulsory.

Group A

1. Multiple Choice Questions **(1x5=05)**

(i) ..

(ii) ..

(iii) ..

(iv) ..

(v) ..

Group B

(Descriptive answer type questions)

Answer any three of the following. **(5x3=15)**

2. ..

3. ..

4. ..

5. ..

6. ..

X

Note: *The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best of Two**" shall be applicable for computation of marks for SIA.*

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

Format of question Paper of End-Semester Theory Examination

Binod Bihari Mahto Koyalanchal University, Dhanbad

End-Semester Examination xxxx (Session: xxxx-xx)

Subject/Code:

Full Marks: 70 Pass Marks: 28 Time: 3Hours

General Instructions:

Candidates are required to give their answers in their own words as far as practicable.

The Questions are of equal value.

Answer any five questions of the following in which Q.1 is compulsory.

Group A

1. (A) Multiple Choice Questions (1x6=06)

(i) ..

(ii) ..

(iii) ..

(iv) ..

(v) ..

(vi) ..

(B) Short answer type questions (4x2=08)

(a) ..

(b) ..

Group B

(Long answer type questions)

Answer any four of the following. (14x4=56)

2. ..

3. ..

4. ..

5. ..

6. ..

7. ..

8. ..

9. Short notes type questions (7x2=14)

(a) ..

(b) ..

(c) ..

(d) ..

X

Semester – I

PHY- F - 101 (Mathematical Physics, Classical Mechanics & Elements of Computational Techniques) (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:
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 **multiple type questions** 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.*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).
***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Mathematical Physics

Unit -1

Vector space: Axiomatic definition, linear independence, bases, dimensionality, inner product; Gram-Schmidt orthogonalisation.
Matrices: Representation of linear transformations and change of base; Eigenvalues and eigenvectors; Functions of a matrix; Cayley-Hamilton theorem; Commuting matrices with degenerate eigenvalues; Orthonormality of eigenvectors. **(08 lectures)**

Unit - 2 :

Group Theory : Definitions; Multiplication table; Rearrangement theorem; Isomorphism and homomorphism; Illustrations with point symmetry groups; Group representations : faithful and unfaithful representations, reducible and irreducible representations; Lie groups and Lie algebra with SU(2) as an example.**(10 lectures)**

Unit – 3 :

Complex analysis :Function of a complex variable - single and multiple-valued function, limit and continuity; Differentiation - Cauchy-Riemann equations and their applications; Analytic and harmonic function; Complex integrals, Cauchy's theorem, Cauchy's Integral Formula and its corollaries; Classification of singularities; Branch point and branch cut; Residue theorem and evaluation **of** some typical real integrals using this theorem.**(14 lectures)**

Classical Mechanics

Unit – 4 :
Generalized coordinates. Lagrangian and Lagrange's equation, Hamiltonian and
Hamilton's equation and their applications, Principle of Least action, Hamilton's principle and characteristic function,
Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes.
Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets. Symmetry, invariance and Noether's theorem. Hamilton – Jacobi equation. Canonical transformation, generating functions, infinitesimal generators, Poisson bracket, Poisson theorems, angular momentum.**(20 lectures)**

Elements of Computational Techniques

Unit – 5 :
Root of functions, integration by trapezoid and Simpson's rule, Solution of First order differential equation using Runge-Kutta method. **(08 lectures)**

Reference Books :

1. G. Arfken: Mathematical Methods for Physicists
2. J. Mathews and R.L. Walker : Mathematical Methods of Physics
3. P. Dennery and A. Krzywicki: Mathematics for Physicists
4. R.V. Churchill and J.W. Brown: Complex variables and Applications
5. M.R. Spiegel: Theory and Problems of Complex Variables
6. W.W. Bell: Special Functions for Scientists and Engineers
7. A.W. Joshi: Matrices and Tensors in Physics
8. A.W. Joshi: Elements of Group Theory for Physicists
9.Classical Mechanics: Herbert Goldestien , Pearson Education N.Delhi.
10. Classical Mechanics: S.L.Gupta, V.Kumar&H.V.Sharma – Pragati Prakashan.
11. Classical Mechanics: Rana and Joag.
12.Classical Mechanics: J.C.Upadhyaya

PHY- C- 102 (Quantum Mechanics-I and Laser Physics) (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:
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 **multiple type questions** 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. The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).
***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Quantum Mechanics - I
Unit – 1 :
Hilbert Space Formalism of Quantum Mechanics: Postulates, Expectation values and probabilities, Explicit representation of operators, The general uncertainty relationship, The minimum uncertainty product.
Test of validity of the Foundations of Quantum Mechanics :The Copenhagen interpretation, the EPR paradox. **(08 lectures)**

Unit-2 :
Harmonic Oscillator by Schrodinger equation and by matrix method, Matrix formulation of Quantum Mechanics, Variational methods-Application to ground state of Hydrogen atom and first excited state of harmonic oscillator. WKB approximation. **(08 lectures)**
Unit-3 :

Schrodinger, Heisenberg and interaction pictures and their applications to linear harmonic oscillator **(06 lectures)**

Unit-4 :
Angular Momentum: Commutation relations for angular operators, Eigen values and Eigenvectors, Pauli spin matrices and spin eigenvectors, addition theorem, Clebsch – Gordon coefficients, angular momentum and rotation, motion in centrally symmetric field, Schrödinger's theory of Hydrogen atom. **(16 lectures)**

LASER :

Unit - 5 :
Basic Principles of Laser, Two level, Three and Four level laser system, Rate equations for three and four level system, threshold pump power, Relative merits and de-merits of three and four level system **(5 lectures)**

Unit – 6 :
Properties of laser beams and types of lasers **:** Coherence properties of laser light, Spatial and temporal coherence, The Nd^{3+} YAG laser, Carbon Di-oxide laser, solid state laser, semiconductor diode laser, quantum well lasers, free electron lasers, and dye lasers.**(7 lectures)**

Unit - 7: Optical resonators, Stability of resonators, Transverse and longitudinal modes, mode selection, Q-factor, losses in a resonator, Principle of Q-switching, Theory of Q-switching for giant pulse, different methods of Q-switching and Mode locking Theory, techniques for mode locking, Non-linear polarization of lasers, Harmonic generation, Second harmonic generation, Phase matching, optical mixing. **(10 lectures)**

Reference Books :

1) Quantum Mechanics – D J Griffiths (Pearson)
2) Principles of Quantum Mechanics – R Shankar (Springer)
3) Quantum Mechanics – Libboff
4) Quantum Mechanics -- Jataily
5) A textbook of Quantum mechanics – Mathews and Venkatesan (Tata-McGrawHill)
6) Quantum Mechanics (Vols 1 and 2) – A. Messiah
7) Quantum Mechanics - L.I. Schiff
8) Quantum Mechanics - E. Merzbacher
9) Quantum Physics – S. Gasiorowicz
10) Modern Quantum Mechanics – J.J. Sakurai
11)The quantum Theory of Light – R. Loudon
12) Laser: Theory and Applications – K. Thyagrajan and A.K. Ghatak
13) Laser Physics – M. Sargent III, M.O. Scully and W.E. Lamb Jr.
14) Elements of Quantum Optics : Meystre and Sargent(Spriger – Verlag)
15) LASER Physics : Srgent, Scully and Lamb

PHY -C- 103 (Electrodynamics and Plasma Physics) (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:
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 **multiple type questions** 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. The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

End Semester Examination (ESE):*There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Electrodynamics :

Unit-1:

Electromagnetic Vector and Scalar Potentials, Wave equation. Lorentz condition. Non – Uniqueness of electromagnetic potentials and concept of gauge.**(6 lectures)**

Unit-2:

Electrodynamics of a moving charge and radiating systems : Lienard – Wiechert potentials and derivation of LW potential of a moving point charge .Electric and Magnetic fields due to uniformly moving point charge and accelerated charge. Angular Distribution of Radiation emitted by accelerated charge. Radiation Damping: Abraham Lorentz formula**.(15 lectures)**

Unit-3:

Relativistic Electrodynamics : Four Vectors, Four vectors of charge , current density and E.M. Potentials . Covariance of Continuity equation and Lorentz condition. Transformation equations for the electromagnetic potentials. Invariance of Maxwell field equation. Maxwell's equation in covariance Four Tensor Form. **(9 lectures)**

Plasma Physics:

Unit -1:

Definition and properties of plasma, Plasma production in laboratory and diagnostics. Microscopic description, Motion of a charged particle in electric and magnetic fields-curvature, gradient and external force drifts. Controlled thermonuclear devices, magnetically confined open and closed systems (linear pinch, mirror machine and Tokamak). Laser-plasmas: inertially confined system. **(14 lectures)**

Unit -2:

General properties and Fundamental concepts of plasma. Introductory idea of different states of matter.

Kinetic theory of plasma: Boltzmann's equation, Boltzmann – Vlasov Equation, Derivation of moment equations.**(08 lectures)**

Unit -3:

Plasma Characteristics: Fundamental equations of MHD, Debye Shielding and plasma parameter, Plasma oscillations . Expression of Alfven Velocity.**(08 lectures)**

Reference Books :

1. Electromagnetic Theory , Chopra & Agarwal
2. Electrodynamics – Gupta , Kumar & Singh
3. Electromagnetic Theory & . Electrodynamics , Satyaprakash
4. Classical Electrodynamics , Jackson (Wiley)
5. Electromagnetic : B.B.Laud (New Age International Publ.)
6. Classical Electrodynamics : P. Sengupta(New Age International Publ.)
7.Introduction to Plasma Physics, F. F. Chen (Plenum Press, 1984)
8. Principles of Plasma Physics, N. A. Krall and Trivelpiece (San Fransisco Press, 1986)
9. Physics of High temperature Plasmas, G. Schimdt (2ndEd., Academic

Press, 1979)
10. The framework of Plasma Physics, R.D. Hazeltine &F.L. Waelbroeck (Perseus Books, 1998)
11.Introduction to Plasma Physics, R.J. Goldston and P.H. Rutherford (IOP, 1995)
12.Plasma Physics: Francis F. Chen (Plenum Press)
13. Plasma Physics by Suresh Chandra , CBS Publishers

PHY- C/P- 104: Optics Lab. (Credit: 05, Lectures: 75 x 2 = 150)

Instruction to faculty members and Question Setter for:
Mid Semester Practical Examination (MSE):
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).
End Semester Practical Examination (ESE):
The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

Time: 6 hours

1. Determination of wavelength of Laser light using Grating .
2. Determination Of Wavelength Of Laser Light by using verniercallipers
3 Determination of thickness of thin wire using Laser light .
4 Verification of Brewster's Law using spectrometer.
5 Determination of wavelength of Sodium light using Michelson Interferometer.
6 Determination of wavelength of Sodium light using Fabry – Perot interferometer.
7 Determination of resolving Power of a Telescope.
8 Determination of specific rotation of given liquid sample using Polarimeter.
9 Determination of resolving power of Prism.
10 Analysis of elliptically polarized light using l/4 plate and Babinet's compensator.
11 Verification of Rayleigh's criterion for the limit of resolution of spectral lines using (a) prism spectrum and (b) grating spectrum.
12 Determination of optical constants of metal in thin film form.

Semester – II

PHY- S – 205 (Skill Development Course: Experimental Methods & Techniques)
(Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:
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 **multiple type questions** 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. The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).
***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will*

contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

Experimental Methods & Techniques :

Unit-1:

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting, Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques. High frequency devices (including generators and detectors).**(20 lectures)**

Unit – 2:

Passive Devices – Resistors – types characteristics – color coding – capacitors – type – characteristics –color coding star and delta connections of resistors and capacitors – chokes – transformers – testing of diodes, transistors and ICs – Multimeter (analog ang Digital) – CRO – waveforms and Lissajous figures – AF and RF oscillators – usage of bread board.**(12 lectures)**

Unit – 3:

Semiconductor diode – Zener diode – Transistor – Transistor configuration – diode rectifier – half wave and full wave – Bridge rectifier – Diode voltage doubler and multiplier.

Regulated power supply, Zener diode voltage regulator [Series and Shunt type] IC Voltage regulators; fixed positive – fixed negative – adjustable.**(12 lectures)**

Unit-4:

Material Characterisation& Surface probe techniques: Principle of AFM, STM, SEM and it's applications.**(6lectures)**

UNIT-5:

Simulation/Modelling: FORTRAN/C, SCILAB, MATHEMATICA, Gnu plot Molecular Dynamics, Monte-Carlo, NAMD, VMD**(10 lectures)**

References Books:

1. Molecular spectroscopy, an Introduction, Jagmohan, Narosa Publication
2. Solid State Physics, Ashcroft/Mermin, Thomson Publishers

PHY -C- 206 (Quantum Mechanics II and Nano Physics) (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:

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 **multiple type questions** 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. The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six*

questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

Quantum Mechanics II

Unit-1:

Approximation method in QM : Time independent perturbation theory, non –degenerate and degenerate cases, Stark effect, Time dependent perturbation theory and Fermi's golden rule, selection rules. Semi-classical theory of radiation-Einstein A and B coefficients. **(10 lectures)**

Unit-2:

Elementary theory of scattering: Laboratory and Centre of mass reference frames, scattering amplitude, differential scattering cross section and total scattering cross section. Scattering by spherically symmetric potentials, partial wave analysis and phase shifts, Born approximation, Rutherford Scattering.**(10 lectures)**

Unit-3:

Identical particles, Pauli exclusion principle, spin-statistics connection. **(03 lectures)**

Unit-4:

Relativistic QM: Klein – Gordon equation and its merit and demerit, Dirac equation, probabilities and current densities, Magnetic moment and spin of electron, free particle solution of Dirac equation and interpretation of negative energy states.**(14 Lectures)**

Quantization of EM field: First quantization and second quantization of EM field. **(3 Lectures)**

Nano – Physics

Unit-5:

Properties of individual nanoparticles : Metal nanoclusters, magic numbers, modelling of nanoparticles, Bulk to nano transitions, Methods of synthesis, Sol-Gel method, chemical Vapour deposition methods, thermolysis, pulse LASER methods.**(8 lectures)**

Unit-6:

Carbon Nanostructures: Nature of carbon clusters, discovery of Fullernes, Carbon Nanotubes - synthesis, electrical and mechanical properties.**(6 lectures)**

Unit-7:

Quantum Wells, Wires and Dots : Preparation of quantum nanostructures, size effects, conduction electron and dimensionality, properties dependent on density of states. DOS in 3-D, 2-D,1-D ,0-D Systems.**(6 lectures)**

Reference Books:

1. Quantum Mechanics: L.I. Schiff (Mc Graw Hill)
2. Quantum Mechanics: T.K. Thankappan
3. Quantum Mechanics: B. Crasman and J.D. Powell (Addison Wesley)
4. Quantum Mechanics: Mathews and Venkateshan
5. Quantum Mechanics : Ghatak and Loknathan
6. Modern Quantum Mechanics : J.J.Sakurai
7. Quantum Mechanics : G. Aruldhas
8. Quantum Mechanics : S. N. Biswas
9. Introduction to Nanotechnology : Pook and Owen
10. Qunum Dots : Jack, Hawylak and Wojs.
11. Introduction to Nanotechnology: Charles P. Poole, Frank J. Owens Wiley Intrersc.
12. Nanotechnology: Basic Sciences and emerging technologies, Mick Wilson,KamaliKannangara, Geo T. Smith.

PHY- C- 207 (Atomic Physics & Statistical Mechanics) (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:

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 **multiple type questions** 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.*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

End Semester Examination (ESE):*There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Atomic Physics (Quantum Approach):

Unit-1:

Quantum states of an electron in an atom, Electron spin, Hydrogen atom spectrum, spectrum of Helium and Alkali atoms, Fine Structures, Relativistic correction for energy levels of Hydrogen, Spectroscopic terms and selection rules, Hyperfine structure and isotopic shift. Lande's 'g' factor, Landes interval rule. Singlet and triplet series of two electron system, Hartee - Fock equation, L – S and J – J coupling, Width of spectral line, Normal and anomalous
Zeeman effect, Paschen – Back effect. **(14 lectures)**

Statistical Mechanics (Quantum Approach):

Unit 2:

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. entropy of mixing and Gibb's Paradox, Liouvilles Theorem and Density Matrix (Quantum Treatment). **(13 lectures)**

Unit 3:

Quantum Statistics: Equation of state of ideal Fermi and Bose gases, Degenerate electron gas and specific heat, Degenerate Bose gas, Bose-Einstein condensation, Thermal properties of Bose-Einstein gas and liquid He4, The Lambda transition, Liquid Helium I and II.**(10 lectures)**

Unit 4:

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. **(9 lectures)**

Unit 5:

High-Density Gases: 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.**(7 lectures)**

Unit 6:

Non-Equilibrium Statistical Mechanics: Langevin's equation and Brownian motion, The Fokker-Planck Equation, Solution on Fokker-Planck Equation.It's application to Brownian motion **(7 lectures)**

Reference Books:

1. Sinha, S.K., "Statistical Mechanics",
2. Kerson& Huang, "Statistical Mechanics",
3. Friedman, H.L., "A Course in Statistical Mechanics",
4. McQuarrie, D.A., "Statistical Mechanics",
5. Landau, L, &Liefshitz, "Statistical Mechanics", Pergaman Press.
6. Statistical Mechanics, R.K.Patharia, Bufferworgh Heinemann
7. Fundamental of Statistical and Thermal Physics, F.Rief, McGraw Hill International Edition.
8. Fundamental of Statistical Mechanics, B.B. Laud, New Age International Pub.
9. R.K.Srivastava&J.Ashok, "Statistical Mechanics".
10. Hill, T.L., "Statistical Mechanics",
11. Gupta & Kumar, "Statistical Mechanics",
12. Agrawal, B.K., Statistical Mechanics.

13. Atomic Spectra and Atomic Structure, Gerhard Hertzberg .

14. Molecular Structure & Spectroscopy , G. Aruldhas: Prentice Hall of India, New Delhi.
15. Fundamental of molecular spectroscopy,Colin N Banwell& Elaine & M. McCash, Tata Mc Graw-Hill publishing company Limited.
16. Introduction to Atomic, molecular and Laser Physics. D.K. Roy &S.N. Thakur.
17. Introduction to Atomic & Molecular Physics by B. Narayan
18. Statistical Mechanics : Satyaprakash and JP Agrawal
19. Statistical Mechanics: BK Agrawal and M Eisner
20. Fundamental of statistical and Thermal Physics : Rief

PHY C/P- 208: (Electronics Lab) (Credit: 05, Lectures: 75X2 = 150)

Instruction to faculty members and Question Setter for: Mid Semester Practical Examination (MSE):
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).
End Semester Practical Examination (ESE):
The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

Time : 6 hours.
1. To draw the forward and reverse characteristics curves of a Zener diode & to study its performance as a voltage regulator.
2. To study output and mutual (transfer) characteristics of FET.
3. To study Characteristics of MOSFET.
4. To study Characteristics of UJT.
5. To find the voltage gain & to study the frequency response of Transistor Amplifier (CE – Mode)
6. To construct OR, AND, NOT and NAND gates and to verify their truth tables.
7. To study Characteristics of SCR(Silicon Controlled Rectifier).
8. To design half and full Adder circuits using basic gates & to verify the respective truth tables.

SEMESTER – III

PHY -A-309: Open Elective: Radiation Safety (Credit: 05, Lectures: 60 + Tutorials: 15) [For the students other than M. Sc. Physics]

Instruction to faculty members and Question Setter for:
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 **multiple type questions** 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.*

The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day &

*Extracurricular activities of 5 marks. "**Best 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).

End Semester Examination (ESE):*There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit - 1:

Basics of Radiation: Origin of radiation, binding energy and Q-value, stable and unstable isotopes, radioactive decay (alpha, beta), mean life and half life, nuclear reactions, kinematics of nuclear reactions. **(10 lectures)**

Unit – 2:

Devices for radiation measurement: Radiation interaction with matter,

Introduction to types of radiation detectors: semiconductor, scintillation and gas detectors;

Geiger-Muller counters, ionization chamber and proportional counters, Principles of radiation counting statistics, dead time and calibration standards.**(12 lectures)**

Unit – 3:

Application of Nuclear techniques: Medical science (e.g., MRI, PET, radiation therapy), Crime detection, Oil & Mining, Water assessment, Food preservation.**(08 lectures)**

Unit – 4:

Radiation Protection Standards: Classification of radioactive sources, Radiation dose to individuals from natural radioactivity in the environment and man-made sources, Basic concept of radiation protection standards: historical background, International Commission of Radiological Protection and its recommendations, the system of radiological protection, justification of practice, optimization of protection and individual limits.
(16 lectures)

Unit – 5:

Regulations, Monitoring, & Radioactive Waste Management: Evaluation of external radiation hazard-effect of distance, tome and shielding, radio toxicity of different radio nuclides and the classification of laboratories, control of contamination-bioassay and air monitoring, chemical protection, Radiation accidents and disaster monitoring.
(14 lectures)

Reference Books :

1. Nuclear and Particle Physics, W. E. Burcham and M. Jobes (Pearson Education, 1995)
2. Radiation detection and measurement, G. F. Knoll (4th Ed., Wiley, 2010)
3. Thermoluninescense Dosimetry, Mcknlay, A. F., Bristol, Adam Hilger (Medical Physics Hand book 5)
4. Fundamental Physics of Radiology, W. J. Meredith and J. B. Massey (John Wright and Sons, 1989)
5. An Introduction to Radiation Protection, A. Martin and S. A. Harbisor (John Willey & Sons, 1981)
6. Medical Radiation Physics, W. R. Hendee (Medical Publishers Inc., 1981)
7. Nuclear Physics : Principles and applications, John Lilley (Wiley, 2001)
8. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (2nd Ed., Elsevier, 2014)
9. Techniques for Nuclear and Particle Physics Experiments, W.R. Leo (2nd Ed., Springer, 2013)
10. IAEA Publications : (a) General safety requirements Part 1, No. GSR Part 1 (2010), Part 3 No. GSR Part 3 (Interium) (2010); (b)Safety Standards Series No. RS-G-1.5 (2002), Rs-G-1.9 (2005), Safety Series No. 120 (1996); (c) Safety Guide GS-G-2.1 (2007).
11. AERB Safety Guide (Guide No. AERB/RF-RS/SG-1), Security of radioactive sources in radiation facilities.
12. AERB Safety Standard No. AERB/SS/3 (Rev. 1), Testing and Classification of sealed Radioactivity Sources.

PHY- C – 310 : Solid State Physics (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:

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 **multiple type questions** 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.*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit – 1 :

Band theory of solids : Bloch equation; Empty lattice band; Number of states in a band; Effective mass of an electron in a band: concept of holes; Classification of metal, semiconductor and insulator; Electronic band structures in solids - Nearly free electron bands; Tight binding method – application to a simple cubic lattice; Band structures in copper, GaAs and silicon; Topology of Fermi-surface;

Quantization of orbits in a magnetic field, cyclotron resonance - de Haas-van Alphen effect; Boltzmann transport equation - relaxation time approximation, Sommerfeld theory of electrical conductivity. **(15 lectures)**

Unit – 2 :

Lattice dynamics and Specific heat: Classical theory of lattice vibration under harmonic approximation; Dispersion relations of one dimension lattices: monatomic and diatomic cases, Characteristics of different modes, long wavelength limit, Optical properties of ionic crystal in the infrared region; Inelastic scattering of neutron by phonon; Lattice heat capacity, models of Debye and Einstein, comparison with electronic heat capacity; Anharmonic effects in crystals - thermal expansion.**(12 lectures)**

Unit – 3 :

Dielectric properties of solids: Electronic, ionic, and orientational polarization; static dielectric constant of gases and solids; Complex dielectric constant and dielectric losses, relaxation time, Debye equations; Cases of distribution of relaxation time, Cole - Cole distribution parameter, Dielectric modulus; Ferroelectricity, displacive phase transition, Landau Theory of Phase Transition.**(11 lectures)**

Unit – 4 :

Magnetic properties of solids: Origin of magnetism; Landau diamagnetism (qualitative discussion); Paramagnetism: classical and quantum theory of paramagnetism; case of rare-earth and iron-group ions; quenching of orbital angular momentum; Van-Vleck paramagnetism and Pauli paramagnetism; Ferromagnetism: Curie-Weiss law, temperature dependence of saturated magnetisation, Heisenberg's exchange interaction, Ferromagnetic domains - calculation of wall thickness and energy; Ferrimagnetism and antiferromagnetism. **(12 lectures)**

Unit – 5 :

Superconductivity: Phenomenological description of superconductivity - occurrence of superconductivity, destruction of superconductivity by magnetic field, Meissner effect; Type-I and

type-II superconductors; Heat capacity, energy gap and isotope effect; Outlines of the BCS theory; Giaver tunnelling; Flux quantisation; a.c. and d.c. Josephson effect; High Tc superconductors (information only).**(10 lectures)**

Reference Books :

1. N.W. Ashcroft and N.D. Mermin: Solid State Physics
2. J.R. Christman: Fundamentals of Solid State Physics
3. A.J. Dekker: Solid State Physics
4. C. Kittel: Introduction to Solid State Physics
5. H. Ibach and H. Luth: Solid State Physics: An Introduction to Theory and Experiment
6. J.P. Srivastava: Elements of Solid State Physics
7. J.P. McKelvey: Solid State and Semiconductor Physics

PHY- C -311 : NUCLEAR & PARTICLE PHYSICS (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:
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 **multiple type questions** 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. The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).
***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit – 1:

Two-body problems: Characteristics of nuclear forces, tensor forces and exchange forces, nucleon-nucleon potential, ground state of the deuteron, excited state of the deuteron. Two-body scattering: Kinematics, cross-sections, low energy neutron-proton scattering, partial wave analysis-phase shift, singlet and triplet scattering, effective range theory, coherent scattering of neutrons by Ortho- and Para-hydrogen, low energy proton- proton scattering, charge independence and charge symmetry of nuclear forces, Isospin formalism, Yukawa interaction. **(16 lectures)**

Unit – 2:

Nuclear Decay:
(a) Beta decay - β+ and β- emissions and electron capture, Neutrino and antineutrino, Fermi's theory of beta decay, Kurie plots, Comparative half-life, allowed and forbidden transitions, selection rules in beta decay, Non-conservation of parity in beta decay.
(b) Gamma decay - Gamma ray spectra, multipole moments, transition probabilities, selection rules, nuclear isormerism, internal conversion, pair production, Mossbauer effects. **(10 lectures)**

Unit – 3:

Nuclear models: Fermi gas model, Liquid drop model and nuclear fission, Bethe-Weizsacker semi-· empirical mass formula, stability of nuclei, Nuclear shell model (single-particle), magic numbers, magnetic moments and Schmidt lines, Collective model of Bohr and Mottelson. **(12 lectures)**

Unit – 4:

Nuclear reactions : Nuclear reaction kinematics, Q-value equation, threshold energy and cross-section of nuclear reactions, partial wave analysis of reaction cross-sections, formation and break up, statistical theory of the compound nucleus, Ghosal experiment, scattering matrix, reciprocity theorem, resonance scattering & reactions, Breit-Wigner formula, direct reactions, optical model, Pre-equilibrium reactions, Heavy ion reactions. **(12 lectures)**

Unit – 5:

Introduction to Particle Physics: Types of interaction between elementary particles, Hadrons and leptons, Symmetry and conservation laws, Elementary ideas of CP and CPT invariance, classification of hadrons, Lie algebra, SU(2) -SU(3) multiplets, Quark model, Gellmann-Okubo mass formula for octet and decuplet hadrons, charm, bottom and top quarks, Gellman – Nishijima formula, Unification of forces. **(10 lectures)**

Reference Books :

1. Nuclear Physics – R.R. Roy and B.P. Nigam (New Age International)
2. Introductory Nuclear Physics – Kenneth S. Krane (Wiley)
3. Atomic and Nuclear Physics (Vol.-2) – S.N. Ghoshal (S. Chand group)
4. Introduction to Nuclear Physics – H.A. Enge (Addison Wesley)
5. Nuclear Physics – I. Kaplan (Narosa Publications)
6. Introductory Nuclear Theory – L.R.B Elton (Sir Isaac Pitman & sons)
7. Elementary Nuclear Theory – H.A. Bethe and P. Morrison (Dover Publications)
8. Nuclear Physics – E. Fermi (University of Chicago press)
9. Nuclei and Particles – E. Segre (W.A. Benjamin)
10. Theoretical Nuclear Physics – J.M. Blatt and V.F. Weisskopf (Dover Publications)
11. Physics of the Nucleus – M.A. Preston (Addison-Wesley Longman)
12. Techniques for nuclear & particle physics experiments – W. R. Leo (John Wiley & Sons Ltd.)

PHY - C/P- 312 (Practical) (Credit: 05, Lectures: 75X2 = 150)

Instruction to faculty members and Question Setter for: Mid Semester Practical Examination (MSE):

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

End Semester Practical Examination (ESE):

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

Time : 6 hours

1. Determination of Magnetic field strength and Resonance frequency using E. S. R.
2. Determination of Operating voltage of G. M. Counter
3. Determination of Energy Band Gap using Four Probe method
4. Determination of Hall coefficient and Hall angle in Hall-effect
5. Determination of Planck's constant
6. Measurement of Dielectric constants of solid and liquid samples
7. Determination of Curie temperature
8. Study of Hysteresis loss in given sample
9. Free running Multivibrator
10. Determining Optical constants of a metal by reflection of light
11. Lattice dynamics

SEMESTER – IV

PHY – E – 413A: Particle Physics – I (Credit: 5, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:

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 **multiple type questions** 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.*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

End Semester Examination (ESE):*There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit -1 :

Basic Concepts: Fundamental particles and their interactions; determination of mass, spin, intrinsic parity and other quantum numbers; fermionic and bosonic fields. **(15 lectures)**

Unit – 2 :

Relativistic kinematics: Relativistic kinematics, Mandelstam variables, crossing symmetry, phase space. **(9 lectures)**

Unit -3 :

Dirac Equation: Invariance of Dirac equation, bilinear covariants, properties of gamma matrices **(9 lectures)**

Unit -4 :

Weak Interaction: Leptonic, semileptonic and non-leptonic weak decays, selection rules for leptons; current-current interaction, neutral current, charge current, V-A theory, decay of neutron and mu-meson, universality. **(17 lectures)**

Unit – 5 :

Neutrino Physics: Neutrino masses and mixing, Dirac and Majorana masses, Beta decay and neutrinoless double beta decay; Neutrino oscillations, solar and atmospheric neutrinos. **(10 lectures)**

Reference Books :

1. Introduction to Elementary Particles - D.J. Griffiths
2. Quarks and Leptons –F. Halzen and A.D. Martin
3. Quantum Field Theory – L.H. Ryder
4. Advanced Quantum Mechanics – J.J. Sakurai
5. Introduction to High Energy Physics - D.H. Perkins
6. Quarles, Leptons and Gauge Fields – K. Huang
7. Gauge Theory of Elementary Particle Physics – T. Cheng and L. Li
8. Particle Physics and Introduction to Field Theory – T.D. Lee
9. Model of Nucleon – R.K. Bhaduri
10. Unitary symmetries and Elementary Particles – D.B. Lichtenberg
11. Relativistic Quantum mechanics –J. Bjorken and S. Drell
12. Relativistic Quantum Fields - J. Bjorken and S. Drell
13. Gauge Theories of Particle Physics – J.R. Aitchison and A. Hey
14. Particle Physics and Cosmology - P Collins, A. Martin and E. Squires
15. Weak Interactions and Modern Particle Physics – H. Georgi
16. Unification and Supersyrnrnetry – R.N. Mohapatra
17. Introduction to Supersyrnmetry and Supergravity - S.P. Misra
18. The Physics of Massive Neutrinos - B. Kayser, F. Gibrat-Debu and F. Pessier
19. Massive Neutrinos in Physics and Astrophysics – R.N. Mohapatra and P.B. Pal

PHY – E – 414A: PARTICLE PHYSICS – II (Credit – 5, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:

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 **multiple type questions** 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. The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).
***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit – 1 :
Space-time and Internal Symmetries: Parity, Charge Conjugation and Time Reversal symmetries, CPT theorem; Lie groups and Lie algebra; Lorentz group; SU(2) and SU(3) groups; Fermi-Bose symmetry and supersymmetry algebra. **(18 lectures)**

Unit – 2:
Quark Model: Baryon and meson multiplets; symmetry breaking; Gell-Mann-Okubo mass formula; charm, bottom and top quarks and higher symmetry. **(12 lectures)**

Unit – 3 :
Gauge Theory: Abelian and non-abelian gauge invariance; colour gauge invariance and QCD; Evolution of gauge coupling, Asymptotic freedom and confinement. **(12 lectures)**

Unit -4 :
Standard Model: Spontaneous symmetry breaking and Higgs mechanism; standard model of electroweak interaction; Fermion masses and mixing,$K^0 - \bar{K}^0$ mixing, CP violation. **(10 lectures)**

Unit -5 :
Beyond the Standard Model: Unification of strong weak and electromagnetic interaction gauge coupling unification, proton decay, hierarchy problem and supersymmetry. **(8 lectures)**

Reference:

1. Introduction to Elementary Particles - D.J. Griffiths
2. Quarks and Leptons –F. Halzen and A.D. Martin
3. Quantum Field Theory – L.H. Ryder
4. Advanced Quantum Mechanics – J.J. Sakurai
5. Introduction to High Energy Physics - D.H. Perkins
6. Quarles, Leptons and Gauge Fields – K. Huang
7. Gauge Theory of Elementary Particle Physics – T. Cheng and L. Li
8. Particle Physics and Introduction to Field Theory – T.D. Lee
9. Model of Nucleon – R.K. Bhaduri
10. Unitary symmetries and Elementary Particles – D.B. Lichtenberg
11. Relativistic Quantum mechanics –J. Bjorken and S. Drell
12. Relativistic Quantum Fields - J. Bjorken and S. Drell
13. Gauge Theories of Particle Physics – J.R. Aitchison and A. Hey
14. Particle Physics and Cosmology - P Collins, A. Martin and E. Squires
15. Weak Interactions and Modern Particle Physics – H. Georgi
16. Unification and Supersyrnrnetry – R.N. Mohapatra
17. Introduction to Supersyrnmetry and Supergravity - S.P. Misra
18. The Physics of Massive Neutrinos - B. Kayser, F. Gibrat-Debu and F. Pessier
19. Massive Neutrinos in Physics and Astrophysics – R.N. Mohapatra and P.B. Pal

PHY – C – 415: Quantum Field Theory (Credit – 5; Lectures: 60 + Tutorials: 15)
Instruction to faculty members and Question Setter for:

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 **multiple type questions** 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.*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).
***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit – 1:
Introduction: Concept of fields and field quanta, various kinds of fields and their characteristics, Inadequacies of quantum mechanics and the necessity of field theory. **(7 lectures)**
Unit – 2:
Physical Concept and mathematical formulation of classical fields: A transition from discrete to continuum space-time picture, Field variables, Relativistic version of action principle, Euler-Lagrange equation, Hamiltonian formalism, Symmetries and the conservation laws in Lorentz invariant form, Noether's theorem. **(11 lectures)**
Unit -3 :
Field Formalism: Schrodinger field and its special characteristics; Lagrangian formalism and Klein-Gordon field, Spinor field, Electromagnetic field. **(11 lectures)**
Unit – 4 :
Second Quantization: Concept of second quantization and Field operators, Quantization of (a) Real scalar field, (b) Complex scalar field, (c) Spinor Field and (d) Electromagnetic field; Normal ordering, Time ordered product, Wick's theorem. **(16 lectures)**
Unit – 5 :
Interacting quantum fields: Lagrangian formalism, Concept of Feynman diagram and rules, Two-body scattering processes: Applications for electron-muon scattering,Bhabha scattering, pair creation and annihilation; Concept of renormalization in quantum field theory, mass and charge renormalization. **(15 lectures)**

References:

1. Relativistic quantum fields, J.D. Bjorken and S.D. Drell, McGraw-Hill, NY, 1964.
2. An introduction to quantum field theory, M.E. Peskin and D.V. Schroeder.
3. Quantum electro-dynamics, W. Greiner and J. Reinhardt, Springer-Verlag, 1992.
4. Quarks and leptons: An introductory course in modern particle physics, Halgen and Martin, Wiley, 1984.
5. Quantum field theory, Itzykson&Zuber.
6. Quantum field theory, L.H. Ryder, Cambridge Univ. Press.

SEMESTER – IV

PHY- E –413B: Electronics -I (Credit: 05, Lectures: 60 + Tutorials: 15)
Instruction to faculty members and Question Setter for:
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 **multiple type questions** 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.*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

End Semester Examination (ESE):*There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit-1:

Operational Amplifier : Differential Amplifier – Circuit Configuration, Dual Input, Balanced Output Differential Amplifier, DC and AC analysis, Inverting and Non – Inverting Inputs, CMRR , Constant Current , Bias Level Translator . Block Diagram of an Operational Amplifier. Open Loop Configuration.Inverting and Non – Inverting amplifiers. Op – amp with negative feed back. Voltage Follower. Input bias current, Input Offset current, Total output offset voltage, Adder, Substractor, Differentiator and Integrator. **(15 lectures)**

Unit-2:

Oscillators: Oscillator's Principles – Types, Frequency, Stability Response. The Phase shift Oscillators. Wein Bridge Oscillatorble Oscillators.Multivibrators – Monostable, astable and Bistable. Comparators, Square wave and Triangular Wave Generators**. [Using Op – Amp only] (10 lectures)**

Unit-3:

Communication Electronics: DSBSC Modulation, Generation of DSBSC waves, Coherent detection of DSBSC waves, SSB Modulation, Generation and Detection of SSB waves.Vestigal side band Modulator, Frequency Modulation and Detection, PCM, Frequency Division Multiplexing (FDM). **(10 lectures)**

Unit-4:

Microwave and Memory Devices: Two – Cavity Klystrons and Reflex Klystrons, Magnetrons, Travelling Wave Tubes, Wave Modes; ROM , RAM and its applications **(7 lectures)**

Unit-5:

Microprocessors: Introduction to Microprocessors, Microcontrollers and Microcomputers, Architecture and Internal operation of INTEL 8085. Instruction OP codes. Operands and Mnemonic Constructing Machine Language code for Instructions , Instructions Execution Timing Diagram, Instruction Word Size and Addressing Modes, Instruction Set, Stacks, Subroutines and Interrupts. Machine and Assembly Language Programming.**(12 lectures)**

Unit-6

Logic Families:

BJT logic families: TTL logic NAND gate circuit, ECL logic OR/NOR gate circuit, analysis and evaluation of logic parameters. **(3 lectures)**

MOS logic families: NMOS inverter circuit and its analysis with linear and non-linear loads, CMOS inverter. **(3 lectures)**

Reference Books:

1. A handbook of Electronics – Gupta and Kumar.
2. Advanced Electronic Communication System – Wayne Tomasi.
3. Digital Principles and Applications – A.P. Malvino and Donald P. Leach.
4. Microprocessor Architecture ,Programming and Applications with 8085/8086 – Ramesh S.Gaonkar.

5. Gayakwad, "Op-Amps and Linear Integrated Circuits",3/e, Prentice-Hall of India
6. Sedra& Smith, "Microelectronic Circuits", 3/e, Sounders College Publishing.
7. Microwave and Radar Engineering: Kulkarni, Umesh Publication
8. Electronic Communication Systems: Kennedy & Davis, TMH

PHY- E- 414B: Electronics -II (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:

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 **multiple type questions** 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. The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit-1

Radar: Basic arrangement of radar system, Azimuth and range measurement, Operating characteristics of a radar system, Derivation of radar range equation. **(6 Lectures)**

Antenna: Antenna action, 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 **(8 lectures)**

Unit-2

Satellite Communications : Satellite Classifications , Look Angles, Spacing and Frequency allocation, Satellite Link Models – Up Link , Down Link, Cross Link Models, satellite Link Equations. CDMA and GSM mobile Transmission,CDMA TDMA FDMA Multiplexing Processes. **(8 lectures)**

Unit-3

Microwave Communications : Advantages of microwave Transmission, Path of long distance and short distance Microwave Communications Loss in Free Space, Atmospheric Effects on Propagation, Flat and Curved earth effect, Skip Distance Fading Sources. Ionospheres and Troposphere Layers and its effect in Microwave Communications.**(8 lectures)**

Unit – 4

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 (g), attenuation constant (a) and phase constant (b), expressions for a and b **(10 lectures)**

Unit-5

Wave-guide: Field expressions for propagating TE and TM waves in hollow circular cylindrical waveguides, impossibility of TEM waves in hollow wave guide, Attenuation in wave guides and Q-factor. **(10 lectures)**

Unit-6

Fiber optic communication: Principles 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, Losses in fibers. **(10 lectures)**

Reference Books:

1. A handbook of Electronics – Gupta and Kumar.
2. Advanced Electronic Communication System – Wayne Tomasi.
3. Gayakwad, "Op-Amps and Linear Integrated Circuits",3/e, Prentice-Hall of India
4. Sedra& Smith, "Microelectronic Circuits", 3/e, Sounders College Publishing.
5. Microwave and Radar Engineering: Kulkarni, Umesh Publication
6. Electronic Communication Systems: Kennedy & Davis, TMH

PHY- E/P – 415B: Electronics Practical (Credit: 05, Lectures: 75X2 = 150)

Instruction to faculty members and Question Setter for: Mid Semester Practical Examination (MSE):

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

End Semester Practical Examination (ESE):

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

1. Study of Converters- A to D and D to A
2. Study of waveform of MonostableMultivibrator using Oscilloscope
3. Study of waveform of Bistablemultivibrator using Oscilloscope
4. Study of Pulse Amplitude Modulation & Demodulation
5. Study of BCD to seven segments
6. Addition, Subtraction, Multiplication using 8085/8086
7. Optical Fibre- Measurement of loss in dB of patch cords
8. Study of Active filters
9. Waveform generation & Storage Amplifier
10. Network Analysis- Verification of Thevenin's& Norton's theorem.
11. Study of the performance of an Op – Amplifier as (i)Differentiator & (ii)Integrator.
12. Logarithmic Amplifier.

SEMESTER – IV

PHY- E – 413C (CONDENSED MATTER PHYSICS -I) (Credit: 05, Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:

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 **multiple type questions** 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.*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.*

Unit – 1 :
X-ray Diffraction Theory: Coherent and incoherent scattering, Derivation of Laue equations and expression for structure factor, Data reduction. **(08 lectures)**

Unit -2 :
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)**

Unit – 3 :
Experimental Techniques: The Weissenberg and Precession methods, The Diffractometer, Area Detector and Image Plate. **(10 lectures)**

Unit – 4 :
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)**

Unit – 5 :
Phonons: Harmonic crystals, Crystal potential; Harmonic and adiabatic approximations; Normal modes and phonons; Phonon spectrum by neutron scattering; Crystal momentum. Anharmoniccrystals, Anharmonicity, Lattice thermal conductivity, Umklapp process; Second sound. **(10 lectures)**

Reference Books :

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

PHY- E – 414C: CONDENSED MATTER PHYSICS -II (Credit : 5 , Lectures: 60 + Tutorials: 15)

Instruction to faculty members and Question Setter for:
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 **multiple type questions** 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.*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. “**Best 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).
***End Semester Examination (ESE):**There will be two groups of questions. Group A is compulsory and will contain two questions. Question No. 1(A) will be multiple type questions consisting of six questions of 1 mark each. Question No. 1(B) will be two short answer type of 4 marks. Group B will*

contain descriptive type eight questions of fourteen marks each, out of which any four are to be answered.

Unit – 1 :

Phase Transformation and Diagrams: phase rule, single component system, Binary phasesystem, lever rule, Nucleation and growth, Nucleation kinetics, Growth and overalltransformation kinetics and applications to steel and glass.**(10 lectures)**

Unit -2 :

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

Unit -3 :

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)**

Unit – 4 :

Superconductivity: BCS theory of superconductivity, Cooper pairs, superconducting groundstate, Flux quantization in superconducting ring, Quasi-particles and energy gaps, Temperaturedependence of energy gaps, London equation, Coherence length, Persistent current, Singleparticle tunneling, Josephson tunneling, Josephson effects (AC and DC), Microscopic quantuminterference, Qualitative idea of high temperature superconductors, Critical fields and moments.**(15 lectures)**

Unit – 5 :

Thin Films: Deposition techniques, thermal, electron and sputtering methods, metallicsemiconductor and insulator thin films and their electrical, electronic and optical properties.Magnetic superconducting thin films and applications. **(15 lectures)**

Reference Books :

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

PHY- E/P – 415C: CONDENSED MATTER PHYSICS PRACTICAL (Credit: 05, Lectures: 75X2 = 150)

Instruction to faculty members and Question Setter for: Mid Semester Practical Examination (MSE):

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each of 3 hours duration (b) Class Attendance Score of 5 marks and (c) Day to Day & Extracurricular activities of 5 marks. "**Best 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).

End Semester Practical Examination (ESE):

The questions in practical examination will be of equal to 70 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.

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 polarizability 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.

PHY- D – 416: Dissertation / Project (Credit: 05, Lectures: 150)

This course will be based on preliminary research oriented topics both in theory and experiments. **Dissertation / Project** works will be given to the students at the beginning of Semester – III.

Dissertation/Project: Evaluation of dissertation/Project work may be as per the following guidelines:

•Mid-Semester/Internal Assessment Examination = 30 marks (Annexure-I)

•End Semester Examination: Project model (if any) and the Dissertation/Project record notebook, Dissertation/Project presentation and viva-voce = 70 marks

(To be conducted jointly by One External Examiner & One Internal Examiner)

Overall evaluation of the Dissertation/Project works may be made 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

Research Methodology (Common for All Faculties)

M.A./M.Sc./M.Com. Courses
Semester-IV
Paper Code: PHY-D-416

Mid Semester Examination (MSE): There will be **two** groups of questions in written examinations of **30 marks.Group A is compulsory** and will contain ten questions of **multiple type questions** consisting of **1 mark** each. **Group B** will contain **descriptive type eight questions** of **five** marks each, out of which any **four** are to be answered.

Broad topics of the syllabus are as under:

Introduction of Research Methodology: Meaning of Research, Objectives of Research, Research Methods

Types of Research: Descriptive vs. Analytical Research, Applied vs. Fundamental Research, Quantitative vs. Qualitative Research, Conceptual vs. Empirical Research

Research Process: Basic Overview; Literature Review; Formulating the Research Problem, Hypothesis, Research Questions, Research Methodology

Data Collection: Primary and Secondary Data, Sampling Method, Observation Method, Interview Method, Questionnaires, Case Study Method, Historical Method, Processing and Analysis of Data, Interpretation of Data/Results, Conclusions/Findings.

Research Writing: Synopsis, Article/Research Paper, Research Project, Thesis, Dissertation, Book, Book-Review, Case Review, Criteria of Good Research, Plagiarism

Citation Style & Methods: MLA, APA, Foot Note, Text Note, End Note, Footnotes, Bibliography, References

Reference Books:

a) Best and Kahn, Research Methodology, PHI Limited.
b) Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.

Note: Guidelines

(a) 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 to the concerned Department of University, for evaluation.
The paper will consist of

- Field work/Lab work related to the project.
- Preparation of dissertation based on the work undertaken.
- Presentation of project work in the seminar on the assigned topic & open viva there on.

(b) Each student 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.

(c) Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular intervals.

(d) Students will select topics for the project work in consultation with a teacher of the Department.

The Seminar will be held in the concerned Department of University.

Format of the Dissertation/Project:

The **Dissertation/Project** shall be presented with the following specifications:

(a) **Size of Paper**: A4. Dissertation/Project must be printed on one side of the paper.

(b) **Font Type**: Times New Roman/Arial for English and KrutiDev 010 for Hindi.

(c) **Font Size**: Font size for English text is 12pt. in standard form and for Hindi is 14pt.

(d) **Font of Chapter Headings and Sub-Headings**:

- Chapter headings may be written in all Capitals, bold text in point size 15
- Sub-headings are written with left margin alignment
- First level sub-headings are written in normal sentence case using bold text in point size 14
- Second level sub-headings are point size 13

(e) **Spacing and Paragraphing**:

- Printing shall be in standardised form with 1.5 line spacing
- Leave as triple spacing (2 empty lines) in base point size 12 before and after sub-headings and one empty line after all sub-headings
- Use one empty line between left-justified paragraphs

(f) **Margin**: Left margin should be 4cms and right and top margin should be 2cms. Bottom margins should be 2.5cms. No ornamental bordering of sides is permitted.

(g) **Page Numbering**: Preliminary pages of the **Dissertation/Project**, i.e. those preceding in text are to be numbered in Roman numbered. Text should be numbered in Arabic beginning with Pg No 1 on the first page of chapter 1.

(h) Preliminary sections of the **Dissertation/Project** should include, Declaration of Attendance**,** Certificate from Supervisor**,** Declaration by Candidate and Supervisor regarding Plagiarism**,** Acknowledgement, Table of Contents, List of Tables, List of Figures/Diagrams, List of Abbreviations (if any) and an Abstract of the Dissertation/Project.

(i) **Referencing and Citation Style**: Citation i.e. a way of giving credit to individuals for their creative and intellectual works that you utilised to support your research, differs by faculty in the style of ordering, punctuating and formatting of name, date, page, work etc.

The referencing of work and Citation style in the Dissertation/Project submitted in **Faculty of Science and Social Science** will be in **American Psychological Association (APA) style (6th edition)**, for **Faculty of Humanities** except for the Indian Languages, format shall be **Modern Language Association (MLA) (8th edition)** and for **Medical Science**, it shall be **Vancouver style**.