HIMACHAL PRADESH TECHNICAL UNIVERSITY
HAMIRPUR-177001 (INDIA)

SCHOOL OF BASIC AND APPLIED SCIENCES

SYLLABUS

(2019-onwards)

FOR

MASTER OF SCIENCE IN PHYSICS
(M.Sc. Physics)

(Two Years Programme)
(Spread Over Four Semesters)

CREDIT DISTRIBUTION FOR POST-GRADUATE PROGRAM

UNDER

CHOICE BASED CREDIT SYSTEM (CBCS)

M.Sc. PHYSICS

This program is named as Master of Science in Physics (M.Sc. Physics). The syllabus for this program is framed under Choice Based Credit System (CBCS) with core, elective and other interdisciplinary courses incorporated as its components. The CBCS enables the students to select subjects as per their interest. Also, diverse lab experiments allow students to understand the fundamental aspects of the subject. Therefore, M.Sc. Physics program provides the students a sound knowledge of the principles of Physics and the basis for careers in its related fields.

Program Objectives

This program aims to train the students in high level theoretical knowledge enabling them to tackle practical complex problems in industrial fields. In addition, M.Sc. Physics Program is meant to develop professional skills among the students which play a major role in industrial and academic life and also give students the experience of teamwork. This program also inculcates strong student competencies in Physics and its applications in a technology-rich as well as interactive environment. It enables the students to apply the scientific knowledge for deeper understanding of the nature and to identify/analyze advanced scientific problems.

Program Outcomes

After completion of the program, the students will apply his/her knowledge and skill to solve different real physical problems. The student will be able to understand and apply basic principles of physics as well as the basic interaction laws that govern our universe. The students will also be able to apply different tools required for describing and understanding the physical systems. Therefore, different approaches and their applicability in a certain domain required for basic sciences as well as industrial applications will be the required goal of the students. At the end of the program, the students will be able to pursue research career in any branch of physics.

THE DETAILS OF CREDIT DISTRIBUTION (Overall)

School	**Program**	**Core credits (Theory + Practical)**	**Foundation Courses credits**	**ID/DS Elective credits**	**Total Credits**	**Marks**
School of Basic and Applied Sciences	Master of Science in Physics (M.Sc. Physics)	Sem I: 16+02=18 Sem II: 16+02=18 Sem III: 16+04=20 Sem IV: 08 = 64	Sem I: 04 Sem II: 04 =08	ID: (Sem III: 04) DS: (Sem IV: 08+04) =16	64+08+ 16 **=88**	Sem I: 6 00 Sem II: 600 Sem III: 600 Sem IV: 500 **= 2300**

COURSE TYPE: CC: Core Course; **DSE:** Discipline Specific Elective; **IDE:** Interdisciplinary Elective; **FC:** Foundation Course

* The details of credit distribution (semester-wise) are mentioned below.

FIRST SEMESTER

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							IA			ESE	Subject Total
							CT	TA	Total		
Core Courses											
1	PHY-411	Mathematical Physics-I	4	-	-	4	20	20	40	60	100
2	PHY-412	Classical Mechanics	4	-	-	4	20	20	40	60	100
3	PHY-413	Quantum Mechanics-I	4	-	-	4	20	20	40	60	100
4	PHY-414	Classical Electrodynamics	4	-	-	4	20	20	40	60	100
Lab Course											
5	PHY-41L-I	Physics Lab-I	-	-	2	2	20	20	40	60	100
Foundation Courses											
6	PHY-SD-I	*Skill Development-I	2	-	-	2	10	10	20	30	50
7	PHY-HM-I	**Human Making-I	2	-	-	2	10	10	20	30	50
Total			**20**	**0**	**2**	**22**	**120**	**120**	**240**	**360**	**600**

Foundation Courses **(Choose any One from each course)**

***Skill Development-I:** (i) Scientific Writing and Presentation, (ii) Teaching and Learning Skills

****Human Making-I :** (i) Vedic Concepts of Physics, (ii) Physics in Everyday Life

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Assessment & Evaluation

IA-Internal Assessment (Theory)-Core Course (CC) & Foundation Course (FC).

Class (Mid Semester) Tests (CT-I + CT-II) = (10+10=**20)** for CC & (05+05=**10)** for FC.
Teacher's Assessment (Assignment/Quizzes/Seminars+Attendance) = (16+04=**20)** for CC & (08+02=**10)** for FC.
ESE-End-Semester Examination = **60** for CC & **30** for FC
Total = (20+20+60 =100) for CC & (10+10+30=50) for FC

IA-Internal Assessment (Practical)

Class (Mid Semester) Test (including performance & Viva-Voce= 20
Teacher's Assessment (File Work & Lab performance+Attendance)=15+05
ESE-End-Semester Examination (written, performance, viva-voce etc.) = 60
Total = 20+20+60 =100

Note: Each lecture hour per week will be considered as one credit and two practical hours as one credit. For each Core Course, there will be 4 lecture hours of teaching per week and the duration of examination of each paper shall be 3 hours. For each Foundation course, there will be 2 lecture hours of teaching per week and the duration of examination of each paper shall be 2 hours.

SECOND SEMESTER

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							IA			ESE	Subject Total
							CT	TA	Total		
Core Courses											
1	PHY-421	Mathematical Physics-II	4	-	-	4	20	20	40	60	100
2	PHY-422	Electronics	4	-	-	4	20	20	40	60	100
3	PHY-423	Statistical Physics	4	-	-	4	20	20	40	60	100
4	PHY-424	Condensed Matter Physics-I	4	-	-	4	20	20	40	60	100
Lab Course											
5	PHY-42L-II	Physics Lab-II	-	-	2	2	20	20	40	60	100
Foundation Courses											
6	*PHY-SD-II	*Skill Development-II	2	-	-	2	10	10	20	30	50
7	**PHY-HM-II	**Human Making-II	2	-	-	2	10	10	20	30	50
Total			**20**	**0**	**2**	**22**	**120**	**120**	**240**	**360**	**600**

Foundation Courses **(Choose any One from each course)**

***Skill Development-II**

(i) Entrepreneurship Development, (ii) Plastic Waste Management and Recycling

****Human Making-II**

(i) Human Values and Professional Ethics, (ii) History of Science and Technology in India

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Assessment & Evaluation

IA-Internal Assessment (Theory)-Core Course (CC) & Foundation Course (FC).
Class (Mid Semester) Tests (CT-I + CT-II) = (10+10=**20)** for CC & (05+05=**10)** for FC.
Teacher's Assessment (Assignment/Quizzes/Seminars+Attendance) = (16+04=**20)** for CC & (08+02=**10)** for FC.
ESE-End-Semester Examination = **60** for CC & **30** for FC
Total = (20+20+60 =100) for CC & (10+10+30=50) for FC

IA-Internal Assessment (Practical)
Class (Mid Semester) Test (including performance & Viva-Voce= 20
Teacher's Assessment (File Work & Lab performance+Attendance)=15+05
ESE-End-Semester Examination (written, performance, viva-voce etc.) = 60
Total = 20+20+60 =100

Note: Each lecture hour per week will be considered as one credit and two practical hours as one credit. For each Core Course, there will be 4 lecture hours of teaching per week and the duration of examination of each paper shall be 3 hours. For each Foundation course, there will be 2 lecture hours of teaching per week and the duration of examination of each paper shall be 2 hours.

THIRD SEMESTER

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							IA			ESE	Subject Total
							CT	TA	Total		
Core Courses											
1	PHY-431	Quantum Mechanics-II	4	-	-	4	20	20	40	60	100
2	PHY-432	Nuclear Physics	4	-	-	4	20	20	40	60	100
3	PHY-433	High Energy Physics	4	-	-	4	20	20	40	60	100
4	PHY-434	Numerical Methods and Programming	4	-	-	4	20	20	40	60	100
Lab Course											
5	PHY-43L-III	Physics Lab-III	-	-	2	2	20	20	40	60	100
		Computer Lab	-	-	2	2					
Interdisciplinary Elective											
6	PHY-43ID	*Interdisciplinary and Applied Sciences	4	0	-	4	20	20	40	60	100
Total			**20**	**0**	**4**	**24**	**120**	**120**	**240**	**360**	**600**

***Interdisciplinary and Applied Sciences (Choose any One)**

(i) Research Methodology
(ii) Environmental Studies
(iii) Science of Renewable Energy Resources

Assessment & Evaluation

IA-Internal Assessment (Theory)-Core Course (CC) & Interdisciplinary course (ID)
Class (Mid Semester) Tests (CT-I + CT-II) = (10+10=**20).**
Teacher's Assessment (Assignment/Quizzes/Seminars+Attendance) = (16+04=**20)**
ESE-End-Semester Examination = **60**
Total = (20+20+60 =100)

IA-Internal Assessment (Practical)

Class (Mid Semester) Test (including performance & Viva-Voce)= 20
Teacher's Assessment (File Work & Lab performance+Attendance)=15+05
ESE-End-Semester Examination (written, performance, viva-voce etc.) = 60
Total = 20+20+60 =100

Note: Each lecture hour per week will be considered as one credit and two practical hours as one credit. For each Core and Elective Course, there will be 4 lecture hours of teaching per week and the duration of examination of each paper shall be 3 hours.

FOURTH SEMESTER

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							IA			ESE	Subject Total
							CT	TA	Total		
Core Courses											
1	PHY-441	Condensed Matter Physics-II	4	-	-	4	20	20	40	60	100
2	PHY-442	Atomic and Molecular Physics	4	-	-	4	20	20	40	60	100
3	PHY-443	Discipline Specific Elective-I	4	-	-	4	20	20	40	60	100
4	PHY-444	Discipline Specific Elective-II	4	-	-	4	20	20	40	60	100
Project:											
5	PHYMS 445	M.Sc. Research Project/Seminar	4 (contact hrs 04 per week)			4	20	20	40	60	100
Total =			**16+4**			**20**	**100**	**100**	**200**	**300**	**500**

Discipline Specific Elective-I (Optional)

(i) Nano Physics
(ii) Advanced Electronics
(iii) Advanced Nuclear Physics

Discipline Specific Elective-II (Optional)

(i) Experimental Techniques in Physics
(ii) Opto-Electronics
(iii) Nuclear Technology

Assessment & Evaluation

IA-Internal Assessment (Theory)-Core Course (CC) & Discipline Specific Elective (DE)

Class (Mid Semester) Tests (CT-I + CT-II) = (10+10=**20).**
Teacher's Assessment (Assignment/Quizzes/Seminars+Attendance) = (16+04=**20)**
ESE-End-Semester Examination = **60**
Total = (20+20+60 =100)

Project/Seminar

(a) Attendance in Two presentations in Project/Seminars and interaction during the work plan/framework: 10 Marks

(b) Knowledge/work done of Subject along with Q/A handling during course work: 10 Marks

(c) Presentation and Communication Skills during two seminars: 20 Marks

(d) Overall Project/Seminar Presentation about the work done/results (in presence of External as well as Internal examiners): 60 Marks.

***Note:** The distribution of internal & external assessment for Project work/Seminar will be same as that of Core course/DSE. Supervisor/Examiner will distribute the marks on the basis of presentations, interaction during the course work, collection resource material, literature survey, setting up of the experiment (if any), theoretical frame work, written work of project/Seminar report and viva as well.

Note: Each lecture/contact hour per week will be considered as one credit. For each Core and Elective Course, there will be 4 lecture/contact hours of teaching per week and the duration of examination of each paper shall be 3 hours.

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SYLLABUS

FOR

MASTER OF SCIENCE IN PHYSICS
(M.Sc. Physics)

(Two Years Programme)
(Spread Over Four Semesters)

FIRST SEMESTER

SYLLABUS SCHEME

Under Choice Based Credit System

(***Effective from Academic year 2019-onwards)***

FIRST SEMESTER

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							IA			ESE	Subject Total
							CT	TA	Total		
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1	PHY-411	Mathematical Physics-I	4	-	-	4	20	20	40	60	100
2	PHY-412	Classical Mechanics	4	-	-	4	20	20	40	60	100
3	PHY-413	Quantum Mechanics-I	4	-	-	4	20	20	40	60	100
4	PHY-414	Classical Electrodynamics	4	-	-	4	20	20	40	60	100
Lab Course											
5	PHY-41L-I	Physics Lab-I	-	-	2	2	20	20	40	60	100
Foundation Courses											
6	PHY-SD-I	*Skill Development-I	2	-	-	2	10	10	20	30	50
7	PHY-HM-I	**Human Making-I	2	-	-	2	10	10	20	30	50
Total			**20**	**0**	**2**	**22**	**120**	**120**	**240**	**360**	**600**

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ESE-End-Semester Examination = **60** for CC & **30** for FC
Total = (20+20+60 =100) for CC & (10+10+30=50) for FC

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SEMESTER-I

PHY-411 Mathematical Physics-I

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes

1. Students will be able to understand and apply the mathematical skills to solve quantitative problems in the study of physics.
2. Students will be able to apply integral transform to solve mathematical problems of interest in physics.
3. The students will be able to formulate and express a physical law in terms of contents mentioned.

Note:

The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit-I: Matrices and Vector Analysis

Dimensional analysis, Linear algebra, matrices, Cayley-Hamilton Theorem, Eigenvalues and eigenvectors, Vector algebra and vector calculus, Vector differential operators: gradient, curl, Divergence and Laplacian, Vector operators in curvilinear coordinates, Gauss's theorem, Green's theorem and Stoke's theorem.

Unit-II: Differential Equations

Linear ordinary differential equations of first & second order, Partial differential equations of theoretical physics, separation of variables, singular points, series solutions-Frobenius method, second solution.

Probability distribution, Binomial distribution, Poisson distribution, Normal distribution, Applications of Binomial, Poisson and Normal distributions, Central limit theorem.

UNIT–III: Complex Analysis

Elements of complex analysis, analytic functions, Analyticity and Cauchy-Reimann Conditions, Cauchy's integral theorem and formula,Taylor, Laurent and Maclaurine series expansion, zeros and singular points, poles, residues and residue theorem, Cauchy's residue theorem, contour integration, Jordan's Lemma, evaluation of definite integrals.

Unit-IV: Delta and Gamma Functions

Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Orthogonal function and Integral representation of Delta function, Gamma function, factorial notation and applications, Beta function, Relation with gamma function.

Books Recommended:

1. Mathematical Methods for Physicists: George B. Arfken and Hans-Jurgen Weber.
2. Mathematics for Physicists and Engineers: Louis A. Pipes.
3. Mathematical Method of Physics: A.K. Ghatak.
4. Analytical Mathematics in Physics: C. Harper, 1st Edition Prentice Hall
5. Mathematical Method- Potter and Goldberg (Prentice hall of India)
6. Vector Analysis (Schaum Series) (McGraw Hill)
7. Advanced Engineering Mathematics: Erwin Kreyszig (John Willey & Sons, Inc.)
8. Mathematical Physics B.D.Gupta, Vikas Publishing House.
9. Mathematical Physics b. S. Rajput, Pragati Prakasam

SEMESTER-I

PHY-412 Classical Mechanics

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes

1. The students will be able to apply the Variational principles to real physical problems.
2. The students will be able to model mechanical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations.

Note:

1. The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

2. The question paper is expected to contain problems with a minimum weightage of 25% of the total marks.

Unit-I: Lagrangian Formulation

Mechanics of a system of particles, Constraints of motion, Generalized coordinates, D'Alembert's Principle and Lagrange's velocity – dependent force and the dissipation fuction, Application of Lagangian formulation.

Hamilton Principle: Calculus of variations, Hamilton principle.Lagrange's equation from Hamilton's principle, Extension to non- holonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

UNIT–II: Rigid Body Motion

Independent co-ordinates of rigid body, orthogonal transformation, Eulerian Angles and Euler's theorems, infinitesimal rotation, Rate of change of vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

UNIT–III: Small Oscillations

Eigenvalue equation, Free vibrations, Normal Coordinates,Vibrations of a triatomic molecule.

Hamilton's Equations: Legendre Transformations, Hamilton's equations of motion, Cyclic-co-ordinates, Hamilton's equations from variational principle, principle of least action.

UNIT-IV: Canonical Transformation and Hamilton- Jacobi Theory

Canonical transformation and its example, Poission brackets. Equations of motion, Angular momentum.Possion's Bracket relations, infinitesimal canonical transformation, Conservation Theorems, Hamilton–Jacobi equations for principal and characteristic functions, Harmonic oscillator problem, Action angle variables for system with one degree of freedom.

Special Theory of Relativity: Preliminaries of special theory of relativity, four vector notation, energy, momentum four-vector for a particle, relativistic invariance of physical laws.

Books Recommended:

1. Classical Mechanics: H. Goldstein (Narosa, New Delhi) 1992.
2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi) (2006)
3. Analytical Mechanics: L.N. Hand and J.D. Finch (Cambridge University Press, Cambridge) 1998.
4. Classical Mechanics: V.D. Barger and M.G. Olsson, (McGraw-Hill, New York) 1973.
5. Classical Mechanics: N.C. Rana and P.J. Joag (Tata McGraw Hill, New Delhi) (2004)

SEMESTER-I

PHY-413 Quantum Mechanics-I

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes

1. Students will be able to understand the need for quantum mechanical formalism and basic principles.
2. Students will be able to understand the importance and implication of vector spaces, dirac ket bra notations, eigen value problems and mathematical foundations of angular momentum of a system of particles.
3. Students will be able to apply various approximation methods in solving the Schrodinger equation as well as perturbation theory to scattering matrix and partial wave analysis.

Note:

1. The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

2. The question paper is expected to contain problems with a minimum weightage of 25% of the total marks.

Unit-I: General Formalism of Quantum Mechanics

Linear Vector Space-Linear Operator, Eigen functions and Eigenvalues, Hermitian Operator, Postulates of Quantum Mechanics, Simultaneous Measurability of Observables, General Uncertainty Relation, Dirac's Notation, Equations of Motion; Schrodinger, Heisenberg and Dirac representation, momentum representation, Density Matrix and its properties.

Unit-II: Energy Eigenvalue Problems

Particle in a box, Linear Harmonic oscillator, Tunneling through a barrier, particle moving in a spherically symmetric potential, System of two interacting particles, Rigid rotator, Hydrogen atom: Separation of the center of mass motion, solution to radial equation

Unit-III: Angular Momentum

Orbital Angular Momentum, Spin Angular Momentum, Total Angular Momentum Operators, Commutation Relations of Total Angular Momentum with Components, Ladder operators,

Commutation Relation of J_z with J_+ and J_-, Eigen values of J^2, J_z, Matrix representation of J^2, J_z, J_+ and J_-, Addition of angular momenta-Clebsch -Gordon Coefficients (j =1/2, 1/2; 1/2, 1; 1, 1), selection rules – recursion relations-computation of Clebsch-Gordon Coefficients,.

Unit-IV: Approximate Methods

Time Independent Perturbation Theory in Non-Degenerate Case, Degenerate Case, Stark Effect in Hydrogen atom, Spin-orbit interaction, Variation Method, Born-Oppenheimer approximation, WKB Approximation and its validity.

Books Recommended:

1. A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, Tata McGraw Hill
2. Quantum Mechanics, G. Aruldhas, Prentice Hall of India
3. Introduction to Quantum Mechanics, David J. Griffiths, Cambridge University Press
4. Quantum Mechanics, L.I Schiff, McGraw Hill
5. Quantum Mechanics - Concepts and Applications, N. Zettili, Wiley
6. Quantum Mechanics, V. Devanathan, Alpha Science Intl Ltd
7. Quantum Mechanics, Ghatak & Loknathan, 1st Edition, MacMillan India

SEMESTER-I

PHY-414 Classical Electrodynamics

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes

1. Students will be able to understand and apply the laws of electromagnetism and Maxwell's equations in different forms and different media.
2. Students will be able to solve the electric, magnetic fields and plane wave problems as well as to analyze propagation of electromagnetic waves through different waveguides.

Note:

1. The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

2. The question paper is expected to contain problems with a minimum weightage of 25% of the total marks.

Unit-I: Electrostatics

Introduction, Work and Energy in electrostatics, Polarization, Laws of electrostatic field in the presence of dielectrics, Energy of the field in the presence of a dielectric, Boundary condition, Poisson and Laplace equations, Earnshaw's theorem, Boundary conditions and Uniqueness theorem, Multipole expansion, Method of electrostatic images.

Magnetostatics: Introduction, Laws of magnetostatics, Magnetic scalar and vector potentials, Magnetic media, magnetization, magnetic field vector, Boundary conditions.

Unit-II: Time Varying Fields

Maxwell's equations, Displacement current, Electromagnetic potential, vector and scalar potential, Gauge transformations; Lorentz and Coulomb Gauge, Poynting theorem, conservation laws for a system of charged particles and electromagnetic field, continuity equation.

Unit-III: Electromagnetic Waves

Plane waves in Non-conducting and conducting media Polarization-linear and circular polarization. Skin effect, Reflection and refraction of electromagnetic waves across a dielectrics

interface at a plane surface between dielectrics. Total internal reflection, Polarization by reflection, Reflection from the surface of a metal.

Unit-IV: Electromagnetic Radiation

Retarded Potentials, Radiation from an oscillating Dipole, Lienard-Wiechert Potentials, Potentials for a charge in uniform motion-Lorentz Formula, Fields of an accelerated charge. Transmission lines and wave guides- TE, TM and TEM modes, rectangular and cylindrical wave guides, resonant cavities, Energy dissipation, Q of a cavity.

Dispersion relations in plasma, Plasma oscillations, Debye shielding, Plasma parameters, magneto plasma, Plasma confinement.

Books Recommended:

1. Jackson J.D. "Classical Electrodynamics", John Wiley & Sons Pvt. Ltd., New York, 2004.
2. Griffiths D.J." Introduction to Electrodynamics", Pearson Education Pvt. Ltd., New Delhi, 2002.
3. Marian J.B and Heald M.A. "Classical Electromagnetic Radiation", Academic Press, New Delhi,
4. Puri S.P. "Classical Electrodynamics", Tata McGraw-Hill Publishing Company, New Delhi.
5. Jordon E.C. and Balmain K.G. "Electromagnetic Waves and Radiating Systems", Prentice Hall of India, New Delhi, 1995.
6 M. Schwartz: Classical electromagnetic theory, Dover publication
7. F.F. Chen- Plasma Physics 4. Bittencourt- Plasma Physics.

SEMESTER-I

Lab Course

PHY-41L-I Physics Lab-I

Credits: 2
Total Marks: 100
(IA: 40+ESE: 60)

Learning Outcomes

1. Students will be able to acquire hands on experience of handling different instruments.
2. Students will be familiar with the various components to be used in various circuits.
3. Students will be able to design and perform scientific experiments as well as accurately record and analyze the results of experiments.

Note: Students are required to perform at least Eight experiments.

Internal assessment for the Lab course will be based on a seminar, number of experiments performed and checked after thorough viva based on the each experiment conducted by the concerned teacher/s during the semester and attendance.
Format for recording practical course work must consists of Experiment No, Aim of the Experiment, Apparatus, Theory, Procedures, Observation, Calculation, Conclusion, Precautions.

1. To determine Planck's constant using photocell/LED.
2. To find wavelength of given laser light using diffraction grating and carry out related studies.
3. To study the characteristics of phototransistor.
4. Solar cell characteristics.
5. Ionization potential of mercury/Neon.
6. To find conductivity of given semiconductor crystal using four probe method.
7. To determine the Hall coefficient for given semi-conductor and study its field dependence.
8. To determine the velocity of ultrasonic in given liquid, using interferometer.
9. To study the characteristics of a LED and determine activation energy.
10. To study the characteristics of LDR (light dependent resistor) and photo voltaic cell.
11. Magnetic susceptibility of Para-magnetic liquids.
12. Velocity of light determination experiment
13. To study Zeeman effect by using Na lamp.
14. To study the dependence of energy transfer on the mass ratio of colliding bodies. Using air track.
15. To study the dependence of frequency of normal modes and their difference in a couples oscillator on the coupling mass
16. To verify the law of conservation of linear momentum in collision using air track

Books Recommended:

1. C.L. Arora Practical Physics S. Chand & company Ltd ,2009
2. S. P. Singh, Advanced Practical Physics Vol I & II, Pragati Prakashan, 15th Ed, 2017
3. S.S.Kapoor and V.,S. Ramamurthy, nuclear Radiation Detectors, Wiley Eastern Ltd, new Delhi, 1986.
4. R.M. Singru, Introduction to Experimental nuclear Physics, John Wiley & Sons 1974.

SEMESTER-I

PHY-SD-I (i) Scientific Writing and Presentation (Optional)

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)
Time-2 Hours

Learning Outcomes:

1. Having successfully completed this course work, students will be able to communicate the results of a review of the scientific literature relevant to course content in writing, using appropriate scientific terminology and formatting.
2. Students will be able to analyze the data from a variety of sources as well as to work independently towards achieving well defined objectives.
3. Students will be able to identify key elements of the scientific domain that are relevant to a research area.

Note: *The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II &III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.*

UNIT-I: Latex

Introduction to Latex, Creating an article with title, author and date, Important parts of a scientific paper, Structure the content as Abstract, sections, sub-sections and the use of list environments, text formatting and page setting, Generating tables of different styles, Inserting different types of graphs and pictures in different ways and sizes, Understand the graphics environment by inserting different types and sizes of graphs, Typesetting equations of varying complexity, single line equations and multiple line equations using tabular environment, Referencing and Bibliography, Preparing reports and book, How to cross reference figures, tables, equations and references and create list of figures and table of contents, How to use Beamer in Latex for creating presentations, Creating Title Slide, Outline of Presentation, Making Bullets, Enumeration, etc, Splitting the slide into multiple columns.

UNIT–II: Microsoft Power Point Presentation

Open a Presentation, Outlines, Slide Structure, Fonts, Colour, Background, Graphs, Spelling and Grammar, Open a New Presentation, Save a Slide Show, Create a New Slide, Add Slides, Insert Pictures, Insert Clip Art, Format Pictures, Crop Images, Format Fonts, Header and Footer, Hyperlinks, Tables, Charts, Slide Themes, Slide Transitions, Rearrange Slides, Preview Presentations, View Outline, tips to make power point presentation more effective, From scratch,

Templates, Adding and formatting graphics, Slide Master, Creating and setting up a custom show, Adding slide transitions & animations, Using more than one theme, Handout, Notes and Prints.

UNIT–III: Excel Spreadsheets

Understanding the basic concepts of a spreadsheet: Templates cells, rows and columns, Cell coordinates, Entering data into a spreadsheet cell, Setting up labels: setting column widths, Aligning data in cells, entering column and row labels, Creating and copying formulas, Making changes in a spreadsheet, inserting rows and columns, deleting rows and columns, Producing a printed copy of the contents of a spreadsheet document, Saving a backup copy of your work, Navigate a worksheet, Edit Data in a Worksheet, Appreciating the power of spreadsheet templates.

Reference:

1. Open Software and standard Open and Licensed software.

SEMESTER-I

PHY-SD-I (ii) Teaching and Learning Skills (Optional)

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)
Time-2 Hours

Learning outcomes:
1. Students will be able to describe the knowledge or skills acquire by the end of a particular assignment, class, course, or program, and help other students understand why that knowledge and those skills were useful to them.
2. Students will be able to provide required vocational, general education and generic skill outcomes to others.

Note: *The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II &III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.*

UNIT-I: Computer Application and Communications Skills

Information and Communication Technology (ICT): Definition, Meaning, Features, Trends, Integration of ICT in teaching and learning, ICT applications: Using word processors, Spread sheets, Power point slides in the classroom, ICT for Research: On-line journals, e-books, Courseware, Tutorials, Technical reports, Theses and Dissertations, ICT for Professional Development, Communication: Definitions–Elements of Communication: Sender, Message, Channel, Receiver, Feedback and Noise, Types of Communication: Spoken and Written; Non-verbal communication, Intrapersonal, interpersonal, Group and Mass communication, Barriers to communication: Mechanical, Physical, Linguistic & Cultural, Skills of communication: Listening, Speaking, Reading and Writing, Methods of developing fluency in oral and written communication.

Unit-II: Pedagogy

Instructional Technology: Definition, Objectives and Types, Difference between Teaching and Instruction, Lecture Technique: Steps, Planning of a Lecture, Delivery of a Lecture, Narration in tune with the nature of different disciplines, Lecture with power point presentation, Versatility of Lecture technique, Demonstration: Characteristics, Principles, planning Implementation and Evaluation,
Teaching-learning Techniques: Team Teaching, Group discussion, Seminar, Workshop, Symposium and Panel Discussion.

UNIT-III: E- Learning, Technology Integration and Academic Resources in India

Concept and types of e-learning (synchronous and asynchronous instructional delivery and means), m-learning (mobile apps); blended learning; flipped learning; E-learning tools (like LMS; software's for word processing, making presentations, online editing, etc.); subject specific tools for e-learning; awareness of e-learning standards- Concept of technology integration in teaching- learning processes; Academic Resources in India: MOOC, NMEICT; NPTEL; e-pathshala; SWAYAM, SWAYAM Prabha, National academic depository, National Digital Library; eSodh Sindhu; virtual labs; eYantra, Talk to a teacher, MOODLE, mobile apps, etc.

Books Recommended:

1. Bela Rani Sharma (2007), Curriculum Reforms and Teaching Methods, Sarup and sons, New Delhi.
2. Brandon Hall, E-learning, A research note by Namahn, found in: www.namahn.com/resources/ .../note-e-learning.pdf.
3. Kumar, K.L. (2008) Educational Technology, New Age International Publishers, New Delhi.
4. Pandey,S.K (2005) Teaching communication, Commonwealth Publishers, New Delhi.
5. Ram Babu,A abd Dandapani,S (2006), Microteaching (Vol.1 & 2), Neelkamal Publications, Hyderabad.
6. Singh,V.K and Sudarshan K.N. (1996), Computer Education, Discovery Publishing Company, New York.
7. Sharma,R.A., (2006) Fundamentals of Educational Technology, Surya Publications,Meerut.
8. Vanaja,M and Rajasekar,S (2006), Computer Education, Neelkamal Publications, Hyderabad.

SEMESTER-I

PHY-HM-I (i) Vedic Concepts of Physics (Optional)

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)

Time-2 Hours

Learning Outcomes:

1. Students will be able to develop physical, moral and societal values.
2. Students will be able to understand Vedas and their concepts linked with science.

Note: *The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II & III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.*

UNIT-I: Introduction

Historical overview, Western and Indian Concepts of Science, Fundamental Properties of a Physical Quantities, Measurement of Mass, Length and Time, Atom, Tanmatra, Structure and Attributes of Matter, Particle Physics, Laws of Motion, Gravity, Astronomy, Optics and Sound.Metallurgy, Earth and Earthquakes, Quotes by Researchers.

UNIT-II: Mechanics and Astronomy

Prakriti- The Material Cause, Mahat, Ahankara, Rta, Kinds of Motion according to Vaisheshik Darshan of Kanad, Elastic Force, Means and Works of Machines, Brief History of Research on Ancient Indian Astronomy, Positional Astronomy, Pre-Sidhantic and Sidhantic Astronomy, an Overview on Archaeostronomy and Ancient Indian Chronology.

UNIT-III: Vedic Cosmology

Purusha-The Efficient Cause, A Universe is Born, Mahat Sphota, Tanmatra, Panch mahabhuta, Concept of Golden Egg and Big bang. Bharatiya Kal-Ganana, Work in the field by great Scholars, like Carl Sagan and others.

Books Recommended:

1. Histrory of Science in India Volume-1, Part-I, Part-II, by SibajiRaha, et al. National Academy of Sciences, India and The Ramkrishan Mission Institute of Culture, Kolkata (2014).
2. Physics in Ancient India by N.G. Dongre and S.G. Nene, National Book Trust, India (2016).
3. Vedic Physics by KeshavDevVerma, MotilalBanarsidass Publishers (2012).
4. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010).
5. Pride of India- A Glimpse of India's Scientific Heritage edited by PradeepKohle et al. SamskritBharati (2006).

SEMESTER-I

PHY-HM-I (ii) Physics in Everyday Life (Optional)

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)

Time-2 Hours

Learning outcomes

1. Every student will be able to study physics on a deeper level and to uses basic physics concepts to navigate everyday life.
2. Every student will be able to build essential scientific knowledge and skills for life-long learning.

Note: *The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II & III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.*

Unit-I: Physics in Earth's Atmosphere

Sun, Earth's atmosphere as an ideal gas; Pressure, temperature and density, Pascal's Law and Archimedes' Principle, Coriolis acceleration and weather systems, Rayleigh scattering, the red sunset, Reflection, refraction and dispersion of light, Total internal reflection, Rainbow.

Unit-II: Physics in Human Body and Sports

The eyes as an optical instrument, Vision defects, Rayleigh criterion and resolving power, Sound waves and hearing, Sound intensity, Decibel scale, Energy budget and temperature control, Physics in Sports: The sweet spot, Dynamics of rotating objects, Running, Jumping and pole vaulting, Motion of a spinning ball, Continuity and Bernoulli equations, Turbulence and drag.

Unit-III: Physics in Technology

Microwave ovens, Lorentz force, Global Positioning System, CCDs, Lasers, Displays, Optical recording, CD, DVD Player, Tape records, Electric motors, Hybrid car, Telescope, Microscope, Projector etc.

Books Recommended:

1. How Things Work, The Physics of Everyday Life, Louis A. Bloomfield, Wiley, 2013.
2. Sears and Zemansky, University Physics (Addison Wesley, Boston, USA) 2007.
3. M. Nelkon and P. Parker, Advanced Level Physics (Heinemann International, London, U.K.) 2012.
4. B. Lal and Subramaniam, Electricity and Magnetism (Ratan Prakashan Mandir, Agra, India) 2013.
5. E. Hecht, Optics (Addison Wesley, Boston, USA) 2001.
6. H. C. Verma, Concepts of Physics (Bharati Bhawan publishers and distributers, New Delhi, India) 2011.

SCHOOL OF BASIC AND APPLIED SCIENCES

SYLLABUS

FOR

MASTER OF SCIENCE IN PHYSICS
(M.Sc. Physics)

(Two Years Programme)
(Spread Over Four Semesters)

SECOND SEMESTER

SYLLABUS SCHEME

Under Choice Based Credit System

(Effective from Academic year 2019-onwards)

SECOND SEMESTER

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							IA			ESE	Subject Total
							CT	TA	Total		
Core Courses											
1	PHY-421	Mathematical Physics-II	4	-	-	4	20	20	40	60	100
2	PHY-422	Electronics	4	-	-	4	20	20	40	60	100
3	PHY-423	Statistical Physics	4	-	-	4	20	20	40	60	100
4	PHY-424	Condensed Matter Physics-I	4	-	-	4	20	20	40	60	100
Lab Course											
5	PHY-42L-II	Physics Lab-II	-	-	2	2	20	20	40	60	100
Foundation Courses											
6	*PHY-SD-II	*Skill Development-II	2	-	-	2	10	10	20	30	50
7	**PHY-HM-II	**Human Making-II	2	-	-	2	10	10	20	30	50
Total			**20**	**0**	**2**	**22**	**120**	**120**	**240**	**360**	**600**

Foundation Courses **(Choose any One from each course)**

***Skill Development-II**

(i) Entrepreneurship Development, (ii) Plastic Waste Management and Recycling

****Human Making-II**

(i) Human Values and Professional Ethics, (ii) History of Science and Technology in India

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Assessment & Evaluation

IA-Internal Assessment (Theory)-Core Course (CC) & Foundation Course (FC).
Class (Mid Semester) Tests (CT-I + CT-II) = (10+10=**20)** for CC & (05+05=**10)** for FC.
Teacher's Assessment (Assignment/Quizzes/Seminars+Attendance) = (16+04=**20)** for CC & (08+02=**10)** for FC.
ESE-End-Semester Examination = **60** for CC & **30** for FC
Total = (20+20+60 =100) for CC & (10+10+30=50) for FC

IA-Internal Assessment (Practical)
Class (Mid Semester) Test (including performance & Viva-Voce= 20
Teacher's Assessment (File Work & Lab performance+Attendance)=15+05
ESE-End-Semester Examination (written, performance, viva-voce etc.) = 60
Total = 20+20+60 =100

Note: Each lecture hour per week will be considered as one credit and two practical hours as one credit. For each Core and Elective Course there will be 4 lecture hours of teaching per week and the duration of examination of each paper shall be 3 hours. For each Foundation course, there will be 2 lecture hours of teaching per week and the duration of examination of each paper shall be 2 hours.

SEMESTER-II

PHY-421 Mathematical Physics-II

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. Students will be able to understand the applications of group theory in all the branches of Physics problems.
2. Students will be able to use Fourier series and transformations as an aid for analyzing experimental data.
3. Use integral transform to solve mathematical problems of interest in Physics and to develop mathematical skills to solve quantitative problems in physics

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit-I: Special Differential Equations and Their Solutions

(Legendre's differential equation: Legendre polynomials, Generating functions, Recurrence Formulae, Rodrigue's formula, rthogonality of Legendre's polynomial; Bessel's differential equation: Bessel's polynomial, generating functions, Recurrence Formulae, orthogonal properties of Bessel's polynomials; Hermite differential equation, Hermite polynomials, generating functions, recurrence relation; Laguerre's differential equation: Laguerre's polynomial, generating function, Recurrence Formulae, orthogonal properties of Laguerre's polynomials.

UNIT-II: Laplace Transforms

Laplace transforms: Linearity property, first and second translation property of LT, Derivatives of Laplace transforms, Laplace transform of integrals, Initial and Final value theorems; Methods for finding LT: direct and series expansion method, Method of differential equation; Inverse Laplace transforms: Linearity property, first and second translation property, Convolution property – Application of LT to differential equations and boundary value problems.

UNIT-III: Fourier Series, Integrals and Transform

Fourier series definition and expansion of a function x–Dirichlet's conditions, Complex representation of Fourier series, problems related to periodic functions, Fourier integrals, convergence of FS, solving simple partial differential equations using Fourier's series- Fourier

transforms: sin, cosine & complex transforms- solving simple partial differential equations using Fourier transform.

Unit-IV: Tensor and Group Theory

Tensor and their ranks, contravariant and covariant tensors, symmetric and asymmetric tensors, Scalars or invariants, The Kronecker delta, Algebraic operations of tensors – sum and difference of tensors, direct product of tensors, Contraction, Extension of the rank, quotient law.

Definition of a group, Multiplication table, Conjugate elements and classes of groups, directs product, Isomorphism, homeomorphism, permutation group, Definitions of the three dimensional rotation group and SU(2).

Books Recommended:

1. Mathematical Methods for Physicists: George B. Arfken and Hans-Jurgen Weber.
2. Mathematics for Physicists and Engineers: Louis A. Pipes.
3. Mathematical Method of Physics: A.K. Ghatak.
4. Analytical Mathematics in Physics: C. Harper, 1st Edition Prentice Hall
5. Mathematical Method- Potter and Goldberg (Prentice hall of India)
6. Vector Analysis (Schaum Series) (McGraw Hill)
7. Advanced Engineering Mathematics: Erwin Kreyszig (John Willey & Sons, Inc.)
8. Mathematical Physics B.D.Gupta, Vikas Publishing House.
9. Mathematical Physics B. S. Rajput, Pragati Prakasam
10. Matrices and Tensors in Physics, A.W. Joshi, New Age Publishers

SEMESTER-II

PHY-422 Electronics

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. Students will be able to use techniques for analyzing analogue and digital electronic circuits.
2. Students will be able to formulate the concepts of operational amplifier, identify major properties of op-amps circuits.
3. Students will be able to provide theoretical knowledge and develop the practical skill in digital systems, logic systems and Microprocessor.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit-I: Operational Amplifier

Differential amplifier, inverting and non-inverting inputs, analysis of inverting and non-inverting amplifier, Effect of negative feedback on input resistance, output resistance, Band width; closed loop gain and offset voltage, Voltage follower, Input bias current, input off-set current, total output offset voltage, CMRR. DC and AC amplifier, Summing, Scaling, instrumentation amplifier, integrator and differentiator, log & antilog Amplifiers, comparators, waveform generators and Regenerative comparator (Schmitt Trigger) using 741 opamp. Oscillator principles, oscillator types, frequency stability, frequency response, Phase shift oscillator.

Unit-II: Sequential Logic

Flip-Flop: Al-Bit memory-The RS Flip-Flop, JK- Flip-Flop, JK master slave-Flip-Flop, T Flip-Flop, D- Flip-Flop-Shift Registers, Synchronous and Asynchronous Counter, Cascade Counters, A/D and D/A Converters.

Unit-III: Microprocessors

Introduction to microcomputers, input/output- interfacing devices, 8085 CPU – Architecture-BUS timings, Demultiplexing the address bus generating control signals, Instruction Set, Addressing Modes, Illustrative Programmes, Writing Assembly Language Programmes, Looping, Counting and Indexing, Counters and Timing Delays, Stack and Subroutine.
Microprocessor Applications, Recent trends in microprocessor technology, Introduction to 8086 microprocessor.

Unit-IV: Modulation & Communication Systems

Basic concepts of communication systems, Need for modulation, Amplitude Modulation, generation of AM waves, Demodulation of AM waves. Frequency modulation, Block diagram of transmitter and super hytrodyne receiver, Digital communication, basic idea about delta modulation, PCM, PPM and PWM, DS BSC modulation, generation of DSBSC waves, coherent detection DSBSC wave, SSB modulation, generation and detection of SSB waves, Vestigial sideband modulation, frequency division multiplexing (FDM).

Books Recommended:

1. Integrated electronics - MiIlman & Halkias.
2. Microprocessor and Interfacing - D. V Hall.
3. Microprocessor Architecture Prog. & Appls. - S. Gaonkar, Wiley-Estern
4. Micro Electronics - Millman & Grabel.
5. Digital Computer Electronics - AP. Malvino and A. Brown.
6. Advanced Electronic Communication System-Wayne Tomasi Phi. Edn.
7. Electronic communication system by Kennedy.
8. Modern digital electronics by R. P. Jain
9. Gaonkar R. S., Microprocessor Architecture, Programming and Applications, Prentice-Hall.
10. Mathur A.P., Introduction to Microprocessors, McGraw-Hill Publishing Co.

SEMESTER-II

PHY-423 Statistical Physics

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. The students will be able to work out equations of state and thermodynamic potentials for elementary systems of particles.
2. The students will be able to use ensemble theory and develop mean field theory for first and second order phase transitions.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit-I: Thermodynamics
Basic ideas about heat, temperature, work done, Laws of thermodynamics and their significance, specific heats, thermodynamic potentials, Maxwell relations significance of entropy, Chemical potentials, Phase equilibrium, entropy of mixing and Gibb's paradox..

Unit-II: Ensembles
Concepts of phase space, microstates, macro states, equal priori probability, ensemble of particles, micro canonical ensemble, macro canonical ensemble, grand canonical ensemble, derivation of partition function, derivation of thermodynamic quantities from each ensembles, Free energy and its connection with thermodynamic quantities.

Unit-III: Classical Statistical Mechanics
Link between entropy and probability, Boltzmann's equation, elementary ideas about three different statistics, classical statistics – Maxwell & Boltzmann statistics, classical Ideal gas equation, equipartition theorem.
Bose-Einstein Statistics: Bose & Einstein statistics, black body radiation, Rayleigh Jeans' formula, Wien's law, Planck radiation law, Bose Einstein condensation, Einstein model of lattice vibrations, Phonons, Debye's theory of specific heats of solids.

Unit-IV: Fermi-Dirac Statistics
Basics for quantum statistics, system of identical indistinguishable particles, symmetry of save functions, bosons, fermions, Fermi & Dirac statistics, Fermi free electron theory, Pauli paramagetism.

Phase transitions and Fluctuations: Type of phase transitions, first and second order phase transitions. Diamagnetism, paramagnetism and ferromagnetism, Ising model, mean-field theories of the Ising model, Thermodynamic Fluctuations, random walk and Brownian motion, introduction to non-equilibrium processes, diffusion equation.

Books Recommended:

1. Statistical Mechanics : R.K. Pathria (Butterworth-Heinemann, Oxford) 2nd edition (2005).
2. Statistical Mechanics : K. Huang (Wiley Eastern, New Delhi) 2011.
3. Statistical Mechanics : B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi) (1988).
4. Elementary Statistical Physics: C. Kittel (Wiley, New York) (1958).
5. F. Reif, Fundamentals of Statistical and Thermal Physics, International Students Edition, Tata McGraw-Hill (1988).
6. B. B. Laud, Fundamentals of Statistical Mechanics, New Age.

SEMESTER-II

PHY-424 Condensed Matter Physics-I

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:

1. The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials.
2. The students will be able to develop an understanding of relation between band structure and the electrical/optical properties of a material.

Note:

The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Crystal Physics

Classification of condensed matter-crystalline and noncrystalline solids, Bonding and internal structure of solids - Ionic, covalent and metallic solids, the van der Waals interaction, hydrogen bonding, crystal symmetry, point groups, space groups, lattices and basis, typical crystal structures, reciprocal lattice, Bragg's law of diffraction, X-ray, neutron, and electron diffraction, Brillouin zone, structure factor.

UNIT-II: Lattice Vibrations and Thermal Properties

Monoatomic and diatomic lattices, normal modes of lattice vibration, phonons and density of states, dispersion curves, specific heat – classical, Einstein and Debye models, Thermal expansion, thermal conductivity, normal and Umklapp processes.

UNIT-III: Free Electron Theory

Dependence of electron energy on the wave vector, E-K diagram. Free electron theory of metals, Thermal and Electrical transport properties, Electronic specific heat, Fermi surface, Motion in a magnetic field: cyclotron resonance and Hall effect, Thermionic emission, Failures of free electron theory.

UNIT-IV: Energy Band Theory

Energy spectra of atoms, molecules and solids- formation of energy bands. Bloch theorem, Kronig-Penny Model, construction of Brillouin zones, extended, reduced and periodic zone schemes, effective mass of an electron, nearly free electron model, tight binding approximation, orthogonalized plane wave method, pseudo-potential method, insulators, conductors and semiconductors.

BOOKS RECOMMENDED

1. Kittel, C.: Introduction to Solid State Physics, Wiley (2007).
2. Ashcroft and Mermin: Solid state Physics, Thomson (2007).
3. Ali Omar: Elementary Solid State Physics, Addison-Wesley (2005).
4. M A Wahab: Solid State Physics-Structure and Properties of Materials, Narosa (2005).
5. Solid State Physics: Theory, Applications & Problems: S. L. Kakani and C Hemrajajani (Sultan Chand & Sons, Delhi) (2014)
6. Principles of the theory of solids: J M Ziman (2nd edition, Cambridge Univ. press)
7. Srivastava J. P., Elements of Solid State Physics, Prentice-Hall of India

SEMESTER-II

Lab Course

PHY-42L-II Physics Lab-II

Credits: 2
Total Marks: 100
(IA: 40+ESE: 60)

Learning Outcomes

1. Students will be able to acquire hands on experience of handling different instruments.
2. Students will be familiar with the various components to be used in various circuits.
3. Students will be able to design and perform scientific experiments as well as accurately record and analyze the results of experiments.

Note: Students are required to perform at least Eight experiments.

Internal assessment for the Lab course will be based on a seminar, number of experiments performed and checked after thorough viva based on the each experiment conducted by the concerned teacher/s during the semester and attendance. Format for recording practical course work must consists of Experiment No, Aim of the Experiment, Apparatus, Theory, Procedures, Observation, Calculation, Conclusion, Precautions.

1. Zener diode: Characteristics and voltage regulation.
2. Experiment on Uni-Junction Transistor and its applications.
3. To study the characteristics of Junction Field Effect Transistor.
4. To study the characteristic of MOSFET.
5. Application of op-amp as inverting and non-inverting Amplifier.
6. To use the op-amp as summing, scaling, averaging amplifier, differentiator and integrator.
7. To study Registors
8. To study Counters
9. Basic Logic Gates, NAND and NOR, XOR, XNOR, combinational Logic
10. Flip-Flops: RS, JK/JK master slave, T and D.
11. Network Analysis-Thevenin and Norton's equivalent circuits
12. Study of clipping and clamping circuits.
13. A/D and D/A conversion
14. To Study the Half and full adder of binary numbers.
15. Design 2:1, 4:1 MUX circuit using basic gates and verify.
16. Addition, Subtraction, Multiplication & Division using 8085/8086
17 BCD to Seven Segment display
18. Fibre Optics communication
19. Modulation and demodulation: AM, FM, PAM.
20. Study of CRO.

Books Recommended:

1. C.L. Arora Practical Physics S. Chand & company Ltd.
2. S. P. Singh, Advanced Practical Physics Vol I & II, PragatiPrakashan.
3. S.S.Kapoor and V.,S. Ramamurthy, nuclear Radiation Detectors, Wiley Eastern Ltd, new Delhi.
4. R.M. Singru, Introduction to Experimental nuclear Physics, John Wiley & Sons.
5. Computational Physics: An Introduction, R.C. Verma, P.K.Ahluwalia & K.C Sharma, New Age Pub.

SEMESTER-II

PHY-SD-II (i) Entrepreneurship Development (Optional)

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)
Time-2 Hours

Learning Outcomes:
1. Students will begin to build consensus around some of the key elements of entrepreneurship education through the analysis of the skills and knowledge required to develop a business plan for a new venture.
2. The students will be able to provide a foundation for better understanding the value and relevance of entrepreneurial knowledge and skills increasingly being delivered to engineering students.

Note: *The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II &III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.*

UNIT-I: Entrepreneur and Entrepreneurship
Nature, Meaning and Concept of Entrepreneurship, Theories of Entrepreneurship, Classification of Entrepreneurs, Competencies and characteristics of successful Entrepreneur, Motivational issues in Entrepreneurship, Seeking Entrepreneurial opportunities, Role of Entrepreneur in Indian economy.

UNIT-II: Creating Entrepreneurial Venture
Starting the business- business idea and innovation, opportunities recognition, product planning and development process, establishing Entrepreneurship in the organization, Project preparation and appraisal Feasibility and evaluation, business plan, format of business plan, writing of business plan, Role and contribution of various development and financial institution for Entrepreneurship development.

UNIT-III: Management of Enterprises
Human resourse, Marketing and financial management related issues of Enterprises, Growth and Social Responsibilities and business ethics.

Books Recommended:
1. Dynamics of Entrepreneurial Development and Management, Vasant Desai, Himalaya Publishing House.
2. Entrepreneurship - New Venture Creation, David Holt, PHI Learning Innovation and Entrepreneurship, Peter Drucker, Harper Business
3. Entrepreneurial Development, SS Khanna, S Chand & Co.
4. Hisrich, R., & Peters, M. (2002). Entrepreneurship. New Delhi: Tata McGraw Hill.

SEMESTER-II

PHY-SD-II (ii) Plastics Waste Management and Recycling (Optional)

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)

Learning Outcomes:

1. The students will be able to ensure the protection of the environment through effective waste management measures.
2. The students will be able to protect the health and wellbeing of people by providing an affordable waste collection service.
3. They will be able to ensure the design and manufacture of products that avoid or minimize waste generation and spread awareness of waste minimization issues.

Note:

The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II &III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.

UNIT-I: Plastics Wastes and its Separation

Introduction, Sources of Plastics Waste, Collection of Plastics Waste, Sorting and segregation methods viz. simple identification techniques, Density Separation, Solvent Separation, floatation technique, Air classification, Melt filtration and Equipment based sorting techniques.

UNIT-II: Plastics Waste Management Techniques

Plastics Recycling–4 R & I approach, code of Practice, types of Recycling viz. Primary (Degradation of thermoplastics, Industrial practices), Secondary (Approaches to secondary recycling, Chemical modification of mixed plastic waste & Injection molding), Tertiary (Chemicals from waste: Pyrolysis, Chemical decomposition) and quaternary (Energy from plastic waste: Introduction, Incinerator, Energy recovery from municipal refuse, Its effect on reuse, Treatment of predominantly plastics waste) techniques, Plastic Waste in Road Construction. Recycling of Medical Waste.

UNIT-III: Biodegradation of Plastics and Environment Issues

Application of biodegraded plastics, Classification, preparation and utilities of degradable plastics, Studies in starch filled plastics, Studies in jute & other natural fiber filled plastics, Collection and segregation of biodegradable plastics, Environment consciousness, Environment education & awareness programmers, Environmental policies, legislation & code of protection.

Books Recommended:

1. Plastic waste, Recovery of Economic Value by Jacob Leidner.
2. Plastics Waste as Potential Source of Energy by O.P. Ratra.
3. Recycling of PVC & PVC Rich fractions from Mix plastics. By M. Sender, Institute of materials publication
4. R. Johanner Brandrup, Recycling and recovery of plastics, Hanser Publishers,New York, 1996.
5. Nabil Mustafa, Plastics Waste Management, Disposal Recycling and Reuse, Marcel Dekker, Inc. New York.

SEMESTER-II

PHY-HM-II (i) Human Values and Professional Ethics (Optional)

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)

Time-2 Hours

Learning Outcomes:
1. Students will be able to relate ethical concepts and materials to ethical problems in specific professions and professionalism.
2. Students will be made available to aware about the types of ethical challenges.

Note: *The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II &III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.*

UNIT-I: Value Education
Understanding value education, self-exploration as the process of value education, continuous happiness and prosperity-the basic human aspirations, right understanding, relationship and physical facilities, happiness and prosperity–current scenario.

UNIT-II: Harmony in the Human Being
Understanding human being as the co - existence of self (I) and the body, Discriminating between the needs of self (I) and the body, Understanding harmony in the self, harmony of the self (II) with the body. Program to ensure Sanyam and Swasthya.

Harmony in the family and society: Harmony in the family–the basic unit of human interaction, values in human to human relationship, trust–the fundamental values in the relationship, respect–as the right evaluation, understanding harmony in the society vision for the universal human order.

UNIT-III: Harmony in the Nature (Existence)
Understanding harmony in nature, interconnectedness, self-regulation.

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics.

Books Recommended:
1. Weiss, Joseph W. Business Ethics: Concepts & Cases, Cengage Learning.
2. Colin Fisher and Alan Lovell. Business ethics and values: Individual, Corporate and International Perspectives, Prentice Hall.
3. Gaur R. R, R Sangal, G P Bagaria. Human values and professional ethics (excel books).
4. Fernando A.C., Business Ethics: An Indian Perspective, Prentice Publications.
5. Nagarazan R.S., Professional ethics and Human values New Age International.
6. R R Gaur, R Sangal, G P Bhagaria, A Foundation Course in Value Education.

SEMESTER-II

PHY-HM-II (ii) History of Science and Technology in India (Optional)

Credits: 2
Total Marks: 50
(IA: 20+ESE: 30)

Time-2 Hours

Learning Outcomes:

1. Students will be made available to understand distinctive features of early human cultures and explains their growth.
2. They will be made able to realize the good science education which is true to the child, true to life and true to the discipline.

Note: *The question paper for the final examination will consist of four sections-A, B, C & D. Section A, B & C will have two questions each from the corresponding units I,II &III of the syllabus. Section D in the paper will be compulsory and will have short answer type questions consisting of six parts of one mark each covering the whole syllabus. Each question from section A, B & C will be of 8 marks while section D will be of 6 marks. The candidates will attempt 4 questions in all, i.e. one question each from the sections A, B & C and the compulsory question from section D.*

Unit-I: Science and Technology

The Beginning, Development in different branches of Science in Ancient India: Astronomy, Mathematics, Engineering and Medicine, Developments in metallurgy: Use of Copper, Bronze and Iron in Ancient India, Development of Geography: Geography in Ancient Indian Literature, Developments in Science and Technology in Medieval India, Scientific and Technological Developments in Medieval India.

Unit-II: Developments in the Field of Science and Technology

Developments in the fields of Physics, Mathematics, Chemistry, Astronomy and Medicine, Innovations in the field of agriculture - new crops introduced new techniques of irrigation etc., Developments in Science and Technology in Colonial India, Early European Scientists in Colonial India- Surveyors, Botanists, Doctors, under the Company‘s Service, Indian Response to new Scientific Knowledge, Science and Technology in Modern India, Development of research organizations like CSIR and DRDO; Establishment of Atomic Energy Commission; Launching of the space satellites.

Unit-III: Prominent Scientists of India and Their Achievements

Prominent scientists of India since beginning and their achievement, Mathematics and Astronomy: Baudhayan, Aryabhtatta, Brahmgupta, Bhaskaracharya, Varahamihira, Nagarjuna, Medical Science of Ancient India (Ayurveda & Yoga): Susruta, Charak, Yoga & Patanjali, Scientists of Modern India: Srinivas Ramanujan, C.V. Raman, Jagdish Chandra Bose, Homi Jehangir Bhabha, Dr. Vikram Sarabhai, Dr A.P.J Abdul Kalam and more.

Books Recommended:

1. History of Science and Technology in India by Dr. Binod Bihari Satpathy.
2. Bose , D. M ., Sen , S. N., and Subba rayappa , B. V. (Eds.), A Concise History of Science in India. Indian National Science Academy, New Delhi, 1971.
3. Chatterji, Sunm Kumar (Ed.), The Cultural Heritage of India. Vol. V. The Ramakrishna Mission Institute of Culture, Calcutta, 1978.
4. Chattopadhyaya, Debiprasad (Ed.), Studies in the History of Science in India (2 Vols.). Editorial Enterprises, New Delhi, 1982.
5. History of Science and Technology in India Hardcover – Import, by G. Kuppuram.

SCHOOL OF BASIC AND APPLIED SCIENCES

SYLLABUS

FOR

MASTER OF SCIENCE IN PHYSICS
(M.Sc. Physics)

(Two Years Programme)
(Spread Over Four Semesters)

THIRD SEMESTER

SYLLABUS SCHEME

Under Choice Based Credit System

(Effective from Academic year 2019-onwards)

THIRD SEMESTER

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							IA			ESE	Subject Total
							CT	TA	Total		
Core Courses											
1	PHY-431	Quantum Mechanics-II	4	-	-	4	20	20	40	60	100
2	PHY-432	Nuclear Physics	4	-	-	4	20	20	40	60	100
3	PHY-433	High Energy Physics	4	-	-	4	20	20	40	60	100
4	PHY-434	Numerical Methods and Programming	4	-	-	4	20	20	40	60	100
Lab Course											
5	PHY-43L-III	Physics Lab-III	-	-	2	2	20	20	40	60	100
		Computer Lab	-	-	2	2					
Interdisciplinary Elective											
6	PHY-43ID	*Interdisciplinary and Applied Sciences	4	0	-	4	20	20	40	60	100
Total			**20**	**0**	**4**	**24**	**120**	**120**	**240**	**360**	**600**

***Interdisciplinary and Applied Sciences (Choose any One)**

(i) Research Methodology
(ii) Environmental Studies
(iii) Science of Renewable Energy Resources

Assessment & Evaluation

IA-Internal Assessment (Theory)-Core Course (CC) & Interdisciplinary course (ID)
Class (Mid Semester) Tests (CT-I + CT-II) = (10+10=**20).**
Teacher's Assessment (Assignment/Quizzes/Seminars+Attendance) = (16+04=**20)**
ESE-End-Semester Examination = **60**
Total = (20+20+60 =100)

IA-Internal Assessment (Practical)

Class (Mid Semester) Test (including performance & Viva-Voce)= 20
Teacher's Assessment (File Work & Lab performance+Attendance)=15+05
ESE-End-Semester Examination (written, performance, viva-voce etc.) = 60
Total = 20+20+60 =100

Note: Each lecture hour per week will be considered as one credit and two practical hours as one credit. For each Core and Elective Course there will be 4 lecture hours of teaching per week and the duration of examination of each paper shall be 3 hours.

SEMESTER-III

PHY-431 Quantum Mechanics-II

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. To give exposure about the various tools employed to analyze the quantum mechanical problems.
2. At the end of the course, the student will be able to understand relativistic effects in quantum mechanics and its need.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit-I: Time Dependent Perturbation Theory

Time Dependent Perturbation Theory-First and Second Order Transitions-Transition to Continuum of States-Fermi Golden Rule-Constant and Harmonic Perturbation, A Charged Particle in an Electromagnetic Field.

Unit-II: Scattering Theory

Scattering Amplitude, Expression in terms of Green's Function, Born Approximation and Its validity, Partial wave analysis, Phase Shifts, Asymptotic behavior of Partial Waves, The Scattering Amplitude in Terms of Phase Shift, Scattering by Coulomb Potential and Yukawa Potential.

Unit-III: Identical Particles

Brief introduction to identical particles in quantum mechanics, The Schrodinger equation for a system consisting of identical particles, symmetric and antisymmetric wave functions, Elementary theory of the ground state of two electron atoms, ortho-and para-helium, Spin and statistics connection, Scattering of identical particles.

Unit-IV: Relativistic Wave Equation

Klein-Gordon Equation-Plane Wave Equation-Charge and Current Density, Application to the Study of Hydrogen Like Atom, Dirac Relativistic Equation for a Free Particle, Dirac Matrices, Dirac Equation in Electromagnetic Field, Negative Energy States.

Quantum Field Theory: Quantization of Wave Fields, Field Quantization of the Non-Relativistic Schrodinger Equation-Creation, Destruction and Number Operators-Anti Commutation Relations-Quantization of Electromagnetic Field Energy and Momentum.

Books Recommended:

1. A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, Tata McGraw Hill
2. Quantum Mechanics, G. Aruldhas, Prentice Hall of India
3. Introduction to Quantum Mechanics, David J. Griffiths, Cambridge University Press
4. Quantum Mechanics, L.I Schiff, McGraw Hill
5. Quantum Mechanics - Concepts and Applications, N. Zettili, Wiley
6. Quantum Mechanics, V. Devanathan, Alpha Science Intl Ltd
7. Quantum Mechanics, Ghatak & Loknathan, 1st Edition, MacMillan India

SEMESTER-III

PHY-432 Nuclear Physics

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:

1. Students will be able to impart knowledge about basic nuclear physics properties and nuclear models for understanding of related reaction dynamics.
2. After the course, students with an understanding of basic radiation interaction and detection techniques for nuclear physics, radioactive decays, nuclear reactions and elementary particle physics.

Note:

The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Nuclear Masses and Nucleon-Nucleon Interaction

Analysis of nuclear masses, nuclear mass formula, stability of nuclei, beta decay and double beta decay. Properties of nuclear states: quantum numbers, angular momentum, Parity, Isotopic spin (isobaric spin, isospin), deuteron problem.

UNIT-II: Nucleon-Nucleon Interaction

Exchange forces and tensor forces, Meson theory of nuclear forces, Nucleon-Nucleon scattering, Spin dependences of nuclear forces, Effective range theory, Symmetry and nuclear force, Isospin invariance and operator general form of the nuclear potential, Yukawa theory of nuclear interaction.

UNIT-III: Nuclear Structure

The Nuclear Shell, Shell Model Potential and Magic Numbers, Spin-Orbit couplings, Valence Nucleons and Ground State Spin of Nuclei, collective structure of Odd-A nuclei, The Nuclear Collective Model: Nuclear Collective Vibrations, Nuclear Collective Rotation, Single-particle motion in a deformed potential.

UNIT-IV: Nuclear Reaction

Types of nuclear reactions, wave function and scattered waves, differential cross-sections, coupled equations and scattered potential, Partial waves, total differential cross-sections and Optical theorem, Optical Potential-average interaction potential for nucleons, energy dependence of potential, Compound nucleus formation and direct reactions, Compound resonances, Berit-Wigner formula, Inverse reactions (Reciprocity Theorem).

Books Recommended:

1 B.L. Cohen, Concepts of Nuclear Physics, (TMH).
2 K.S. Krane, Introductory Nuclear Physics (John Wiley & Sons).
3 S.S.M. Wong, Introductory Nuclear Physics (Printice Hall of India)
4 R.R. Roy and B.P. Nigam, Nuclear Physics (New Age International, 2000).
5. H.S. Hans, Nuclear Physics: Experimental and Theoretical:, (New Academic Science Ltd., Second revised edition) (2010).
6. Nuclear Physics: D.C. Tayal, (Himalaya Publishing House) (2011).
7. Introduction to Nuclear and Particle Physics V.K. Mittal, R.C. Verma, & , S.C. Gupta, PreniceHall of India (3rd edition: 2013).
8. H. Enge, Introduction to nuclear Physics, Addison Wesley.

SEMESTER-III

PHY-433 High Energy Physics

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. Students will be able to learn standard model of particle physics and its limitations and the properties.
2. Students will be able to learn various global and local gauge symmetries of system, invariance of action, symmetry breaking and Physics beyond the Standard Model Physics etc.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Introduction and Overview

Historical development, Particle classification: Bosons, Fermions, Particles and Antiparticles, Quarks and Leptons; Basic ideas about the interactions and fields in Particle Physics, Types of interactions: Electromagnetic, Weak, Strong and Gravitational, Natural System of Units in High Energy Physics.

UNIT-II: Invariance Principles and Conservation Laws

Conservation of electric charge, Baryon number, Lepton number, Continuous symmetry transformations: translation and rotation; Parity, Pion parity, Charge conjugation, Strangeness and Isospin, Two Nucleon System, Pion-Nucleon System, G-parity, Time reversal invariance, Associated production of particles and Gell-Mann Nishijima scheme, 0−0 doublet, CP violation in K- decay, CPT theorem.

UNIT-III: Electromagnetic Interactions

Form factors of nucleons. Parton model and Deep inelastic scattering structure functions, Cross Section and Decay Rates.

QCD and Quark Model: Asymptotic freedom and Infrared slavery, confinement hypothesis, Classification of hadrons by flavor symmetry: SU(2) and SU(3) multiplets of Mesons and Baryons, The Baryon Octet and Decuplet, Pseudoscalar mesons and Vector mesons.

UNIT-IV: Weak Interactions

Classification of weak processes, Fermi theory of - decay, Parity non conservation in - decay, two component theory of neutrino and determination of helicity, V-A interaction, Strangeness changing and non-changing decays, Cabibbo's theory.

Gauge invariance and Unification schemes: Global and Local invariance of the Action, Noether's theorem, Spontaneous breaking of symmetry and Goldstone theorem. Abelian and Non-Abelian gauge fields.

Books Recommended:

1. Introduction to High Energy Physics, D.H. Perkins.
2. Introduction to Particle Physics, M.P. Khanna.
3. Introduction to Elementary Particles, D. Griffiths.
4. Particle Physics, Martin and Shaw.
5. Introduction to Quarks and Partons, F.E. Close
6. Quarks and Leptons: An Introductory Course in Modern Particle Physics, F. Halzen and A.D. Martin.

SEMESTER-III

PHY-434 Numerical Methods and Programming

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
Students will be able to learn Numerical Analysis such as solutions of nonlinear equations in one variable, interpolation and approximation numerical differentiation and integration, direct methods for solving linear systems, numerical and solution of ordinary differential equations.
Note:

The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Roots of Equations
Non-linear equation: Approximate values of roots, Bisection Method, Regula-Falsi Method, Newton-Raphson method, Solution of set of non-linear equations. Solution of Simultaneous Linear equation: Direct Method: Gauss elimination, Pivoting, Gauss-Jordon method, Matrix inversion. Iterative methods: Jacobi iteration method, Gauss Seidel iteration method. Precision and accuracy, Error analysis, propagation of errors, Linear and non-linear curve fitting–least squares fitting, chi-square test.

UNIT-II: Curve Fitting and Interpolation
Method of least squares, straight line, parabola, Weighted least squares approximation, Method of least squares for continuous functions, Interpolation, Newton's formula for forward and backward interpolation, Divided difference, Symmetry of divided differences, Newton's general interpolation formula, Lagrange's interpolation formula, Cubic splines, Interpolation in multi dimension.
Eigenvectors and Eigenvalues: homogeneous equations, characteristic equation. Secant method, Order of convergence in different Power method, Jacobi method, Applications.

UNIT-III: Integration
Newton – cotes formula – Trapezoidal rule, Simpson's rule, Simpson's 3/8 rule, Error estimates in trapezoidal and Simpson's rule, Gauss quadrature, Numerical evaluation of singular integrals, Numerical calculation of Fourier integrals.
Differential Equations: Ordinary differential equation: Euler's method, Modified Euler's method, Runge-Kutta Method, system of coupled first order ordinary differential equations, shooting method, Partial differential equations, solution of Laplace equation, Poission Equation, and heat equation.

UNIT-IV: Programming With C^{++}

Representation of constant, variables and functions, arithmetic expressions and their evaluation. Assignment statements, Logical constants variables and expression, input and output statements, control statements, Ternary Operator, Go to Statement, Switch Statement, Unconditional and Conditional Looping. While Loop. Do-while Loop, For Loop. Break and Continue Statements. Nested Loops, sequencing alternation, arrays, Manipulating vectors and matrices.

Programming with MATLAB: Basic features of MATLAB: Variables, comments, Matlab workspace, simple math,complex numbers, mathematical function, operation on vectors and matrices, Logical arrays, control structure: For loops, While loops, If-else end, Switch-case statements, Optimization tools in MATLAB.

Books Recommended:

1. S. S. M. Wong, Computational Methods in Physics and Engineering, World Scientific.
2. V. Rajaraman,Computer Oriented Numerical Methods, Prentice Hall of India.
3. V. Rajaraman,Computer Programming in FORTRAN 90/95.
4. Joe D. Hoffman, "Numerical methods for scientist and engineers", Marcel Dekker Inc, 14 New York
5. Steven C Chapra, Raymond P Canale "Numerical Methods for Engineers", Tata McGraw-Hill Education
6. Srimanta Pal "Numerical Methods: Principles, Analysis, And Algorithms", Oxford University Press
7. Scarbrough James B "Numerical Mathematical Analysis", Oxford and IBH Publishing Company, New Delhi, (1966).
8. S.D. Conte "Elementary Numerical Analysis", Tata McGraw Hill Publishing Company, New Delhi.

SEMESTER-III

Lab Course - PHY-43L-III

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)

Learning Outcomes

1. Students will be able to acquire hands on experience of handling different instruments.
2. Students will be familiar with the various components to be used in various circuits.
3. Students will be able to design and perform scientific experiments as well as accurately record and analyze the results of experiments.
4. Students will be able to learn different computer programming.

Note: Students are required to perform at least Eight experiments from Section A (Physics Lab-III) and at least Four experiments from section B (Computer Lab).

Internal assessment for the Lab course will be based on a seminar, number of experiments performed and checked after thorough viva based on the each experiment conducted by the concerned teacher/s during the semester and attendance.

Format for recording practical course work must consists of Experiment No, Aim of the Experiment, Apparatus, Theory, Procedures, Observation, Calculation, Conclusion, Precautions.

PHYSICS LAB-III

Section-A

1. Kelvin double bridge: determination of low resistance.
2. Anderson bridge: determination of self-inductance.
5. Millikan's oil drop experiment.
6. Cauchy's Constant.
7. Dielectric constant of a liquid by dipole meter.
8. Determination of wavelength and difference in wavelengths of sodium lines, and thickness of mica sheet using Michelson Interferometer.
9. To find the wavelength of monochromatic light using Febry Perot interferometer.
10. e/m of electron by helical method.
11. B-H curve of a given material and to determine its parameters.
12. Stefan's constant.
13. Study of variation of modulus of rigidity and internal friction of a specimen rod with temperature.
14. G. M. Counter (a) characteristics, (b) dead time (c) absorption coefficient of given material.
15. Determining thickness of a thin wire by diffraction using laser beam
16. To determine the operating voltage of a –photomultiplier tube and to find the photopeak efficiency of a Nal (Tl) crystal of given dimensions for gamma rays of different energies.

17. To calibrate a gamma ray spectrometer and to determine the energy of given gamma ray source.

Section-B

Computer Lab

Computer based experiments using C++/Mathematica/MATLAB.

1. Statistical and error analysis of (a) given data (b) error estimation in computation.
2. (a) Roots of a quadratic/ cubic equation (b) summation of a series.
3. Numerical differentiation and integration of simple functions.
4. Operations on a matrix (a) inversion (b) diagonalisation (3x3 matrix) (c) solution of simultaneous equations.
5. Plotting and interpolation of a function.
6. Finding the value of Pi using montecarlo method
7. Computer Simulation of Problems by Mathematica: dealing with algebra, differential and integralcalculus, and powerful graphics tools.

Books Recommended:

1. C.L. Arora Practical Physics S. Chand & company Ltd ,2009
2. S. P. Singh, Advanced Practical Physics Vol I & II, Pragati Prakashan, 15th Ed, 2017
3. S.S.Kapoor and V,S. Ramamurthy, nuclear Radiation Detectors, Wiley Eastern Ltd, new Delhi, 1986.
4. R.M. Singru, Introduction to Experimental nuclear Physics, John Wiley & Sons 1974.
5. Open Software and standard Open and Licensed software.

SEMESTER-III

PHY-43ID (i) Interdisciplinary Elective (Optional)

Research Methodology

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)

Learning Outcomes:
1. At the end of this course, the students should be able to understand some basic concepts of research and its methodologies.
2. Students will be able to identify appropriate research topics, select, define appropriate research problem and parameters.
3. Students will be able to prepare, organize and conduct research project/proposal.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit I: Research Methodology

Meaning of research, Objectives & Motivation of Research, Types of research, Basic and applied research, Research approaches; quantitative and qualitative, Significance of Research, Research Process, Criteria of Good research, Selection of research Problem, Literature survey.

UNIT-II: Introductory Concepts on Research Methods in Sciences

Curiosity and Research, Common sense vs. Sciences, Role of Observation and Scientific Methods, Experiments as the basis of Sciences, Various types of Research Methods in Sciences, Discussion of various research methods.
Overview of Research Process: Problem Definition, Proposition of Hypotheses, Hypothesis Testing, Types of Possible Errors in Hypothesis Testing, Proposition of Models and Theories, Literature Review, Experimental Design, Sampling and Survey, Measurement of Values and Dealing with Errors, Validation of Results, Improving Theories, Models and Experiments, Safety and Ethics.

Unit III: Research Design

Meaning of Research Design, Need for Research Design, Features of Good Design, Concepts – Different Research Design, Basic Principles of Experimental Designs.
Preparing the oral report, presenting the oral report in scientific seminar Planning the assignment, Defining and limiting the problem, time schedule, Poster Presentation, Elements and Significance of poster presentations, Planning and designing a poster, presenting the oral and poster reports in scientific seminar, preparing the working bibliography.

Unit IV: Documentation and Presentation

Scientific Proposal Writing, Scientific Report Writing, Parts of a Scientific Report, Presentations, Ethical Issues in Report Writing, Writing the thesis: Planning the thesis, Referencing, Appendixes.

Interpretation of Data and Paper Writing, Layout of a Research Paper, Journals and their Impact factor, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Books Recommended:

1. Michael P Marder, 2011, Research Methods for Science, Cambridge University Press.
2. Eugene Bright Wilson, 1991, An Introduction to Scientific Research, Dover Publications Inc.
3. Ranjit Kumar, 2011, Research Methodology: A Step by Step Guide, Sage South Asia Publication.
4. Research Methodology – C R Kothari, New age International, New Delhi - 2004
5. Research Ed C.Hawkins& M Sorgi, Norosa Publishing House, New Delhi - 2000
6. A hand Book of Methodology of Research, Rajammal et al., Sri Ramakrishna Mission Vidyalaya Press, Coimbatore.

SEMESTER-III

PHY-43ID (ii) Interdisciplinary Elective (Optional)

Environmental Studies

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)

Learning Outcomes:
1. Students will be able to possess the intellectual flexibility necessary to view environmental questions from multiple perspectives, prepared to alter their understanding as they learn new ways of understanding.
2. Students will be able to solve problems systematically, creatively, and reflexively, ready to assemble knowledge and formulate strategy.
3. Students will be able to access necessary scientific concepts and data, consider likely social dynamics, and establish integral cultural contexts.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Introduction
Introduction to environmental studies, Multidisciplinary nature of environmental studies; Scope and importance; the need for environmental education, Concept of sustainability and sustainable development.

UNIT-II: Environmental Pollution and Global Environmental Issues
Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture, Green House effect – causes and associated hazards.

UNIT-III: Energy Resources
Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs.
Land degradation, soil erosion and desertification, Deforestation its Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
Disaster management, floods, earthquake, cyclones and landslides, Resettlement and rehabilitation of project affected persons.

UNIT-IV: Environmental Management
Environmental ethics: Role of human in environmental conservation. Green Politics, Earth Hour, Green Option Technologies, ISO standards, Environmental communication and public awareness, Role of National Green Tribunal, Environment Laws.
Human population growth: Impacts on environment, human health and welfare. Family Welfare Programs, Human Rights.

Books Recommended:

1. Fundamentals of Environmental Science: G. S. Dhaliwal, G. S. Sangha and P. K. Raina, Kalyani Publication
2. Environmental Science (6th ed) (1997): Jr. G. T. Miller, Wadsworth Pub. Co
3. Basu, M. and Xavier, S., Fundamentals of Environmental Studies, Cambridge University Press, 2016.
4. Mitra, A. K and Chakraborty, R., Introduction to Environmental Studies, Book Syndicate, 2016.
5. Enger, E. and Smith, B., Environmental Science: A Study of Interrelationships, Publisher: McGraw-Hill Higher Education; 12th edition, 2010.
6. Basu, R.N, Environment, University of Calcutta, 2000.
7. Agrawal, KM, Sikdar, PK and Deb, SC, A Text book of Environment, Macmillan Publication, 2002.

SEMESTER-III

PHY-43ID (iii) Interdisciplinary Elective (Optional)

Science of Renewable Energy Resources

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)

Learning Outcomes:

1. Students will be able to make interpretation about the energy source.
2. Students will be able to comprehend the energy and energy types solar, geothermal, wind.

Note:

The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Introduction

Energy: Past, Today, and Future. A brief history of energy consumption, Energy & Environment, Non-renewable energies, Production and reserves of energy sources, India, need for alternatives, renewable energy sources.

UNIT-II: Solar Energy

Basics of Solar Energy, radiation measuring instrument, Basics of Flat plate collectors, Concentrators Solar Principle of photovoltaic conversion of solar energy. Application of solar energy.

Wind Energy: characteristics and measurement, Wind energy conversion principles, Types and classification of WECS, Wind Turbines, Environmental Impact.

UNIT-III: Biomass Energy

Classification of biomass. Physicochemical characteristics of biomass as fuel. Biomass conversion routes.

Small Hydropower: Overview of micro, mini and small hydro system, types of hydro turbine.

UNIT-IV: Ocean Energy

Principle of ocean thermal energy conversion system, Principles of Wave and Tidal energy conversion.

Geothermal Energy: Origin of geothermal resources, type of geothermal energy deposits. Hydrogen as a source of energy.Types of fuel cell, fuel cell system.

Books Recommended:

1. Aldo V. da Rosa, "Fundamentals of Renewable Energy Processes", 2005, Academic Press.
2. Solar Energy: *S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.*
3. Conventional Energy Resources Navani J.P. (Author), SapraSonal (Author), Publisher: S Chand & Company.
4. Direct energy conversion, M.A. Kettani, Addision Wesley Reading, 1970.
5. Hand book of Batteries and fuel cells, Linden, McGraw Hill, 1984.

SCHOOL OF BASIC AND APPLIED SCIENCES

SYLLABUS

FOR

MASTER OF SCIENCE IN PHYSICS
(M.Sc. Physics)

(Two Years Programme)
(Spread Over Four Semesters)

FOURTH SEMESTER

SYLLABUS SCHEME

Under Choice Based Credit System

(Effective from Academic year 2019-onwards)

FOURTH SEMESTER

Sr. No.	Subject Code	Subject	L	T	P	Credits	Evaluation Scheme				
							IA			ESE	Subject Total
							CT	TA	Total		
Core Courses											
1	PHY-441	Condensed Matter Physics-II	4	-	-	4	20	20	40	60	100
2	PHY-442	Atomic and Molecular Physics	4	-	-	4	20	20	40	60	100
3	PHY-443	Discipline Specific Elective-I	4	-	-	4	20	20	40	60	100
4	PHY-444	Discipline Specific Elective-II	4	-	-	4	20	20	40	60	100
Project:											
5	PHYMS 445	M.Sc. Research Project/Seminar	4 (contact hrs 04 per week)			4	20	20	40	60	100
Total =			**16+4**			**20**	**100**	**100**	**200**	**300**	**500**

Discipline Specific Elective-I (Optional)

(i) Nano Physics
(ii) Advanced Electronics
(iii) Advanced Nuclear Physics

Discipline Specific Elective-II (Optional)

(i) Experimental Techniques in Physics
(ii) Opto-Electronics
(iii) Nuclear Technology

Assessment & Evaluation

IA-Internal Assessment (Theory)-Core Course (CC) & Discipline Specific Elective (DE)

Class (Mid Semester) Tests (CT-I + CT-II) = (10+10=**20).**
Teacher's Assessment (Assignment/Quizzes/Seminars+Attendance) = (16+04=**20)**
ESE-End-Semester Examination = **60**
Total = (20+20+60 =100)

Project/Seminar

(a) Attendance in Two presentations in Project/Seminars and interaction during the work plan/framework: 10 Marks
(b) Knowledge/work done of Subject along with Q/A handling during course work: 10 Marks
(c) Presentation and Communication Skills during two seminars: 20 Marks
(d) Overall Project/Seminar Presentation about the work done/results (in presence of External as well as Internal examiners): 60 Marks.

***Note:** The distribution of internal & external assessment for Project work/Seminar will be same as that of Core course/DSE. Supervisor/Examiner will distribute the marks on the basis of presentations, interaction during the course work, collection resource material, literature survey, setting up of the experiment (if any), theoretical frame work, written work of project/Seminar report and viva as well.

Note: Each lecture/contact hour per week will be considered as one credit. For each Core and Elective Course there will be 4 lecture/contact hours of teaching per week and the duration of examination of each paper shall be 3 hours.

SEMESTER-IV

PHY-441 Condensed Matter Physics - II

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials; and develop an understanding of relation between band structure and the electrical/optical properties of a material.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Semiconductors

Semiconductor materials, crystal structure, valence bonds, energy bands, density of states, intrinsic carrier concentration, donors and acceptors, effective mass, carrier drift, mobility effects, Hall effect in semiconductors, Dielectric properties: Local electric field at an atom, Clausius-Mossotti equation, dielectric constant and polarizability- classical theory of electronic polarizability, dipolar polarizability, piezo-, pyro- and ferroelectric crystals, ferroelectricity, ferroelectric domains, antiferroelectricity and ferrielectricity.

UNIT-II: Magnetism

Classification of magnetic materials, origin of permanent magnetic moments, Langevin's classical theory of diamagnetism, quantum theory of paramagnetism, ferromagnetism, Weiss molecular field, ferromagnetic domains, antiferromagnetism, ferrimagnetism and ferrites, magnons, neutron scattering.

UNIT-III: Superconductivity

Meissner effect, London equation, Type I and II superconductors, thermodynamics, superconducting band gap, Cooper pairs, flux quantization, BCS theory (qualitative), Josephson Effect, SQUIDS, high temperature superconductors. Physics of nanomaterials: Mesoscopic

Physics, quantum wire, well and dot, size and interference effects, quantum confinement and Coulomb blockade, imaging techniques for nanostructures - electron microscopy, scanning tunnelling microscopy and atomic force microscopy.

UNIT-IV: Defects in Crystals

Point defects - Frenkel and Schottky defects, colour centres, excitons, Dislocations - models of screw and edge dislocations, Burgers vector, Surface imperfections – grain boundaries, tilt boundaries, twin boundaries and stacking faults, Volume defects.

Books Recommended

1. Kittle, C.: Introduction to Solid State Physics, Wiley (2007).
2. Ashcroft and Mermin: Solid state Physics, Thomson (2007).
3. Ali Omar: Elementary Solid State Physics, Addison-Wesley (2005).
4. M A Wahab: Solid State Physics: Structure and Properties of Materials, Narosa (2005).
5. Sze S. M., Semiconductor Devices: Physics and Technology; John Wiley and Sons (2002)
6. Solid State Physics: Theory, Applications & Problems: S. L. Kakani and C Hemrajajani (Sultan Chand & Sons, Delhi) (2014)
7. Principles of the theory of solids: J M Ziman (2nd edition, Cambridge Univ. press) (1979

SEMESTER-IV

PHY-442 Atomic and Molecular Physics

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:

1. Students will be able to learn Atomic Physics with problem solving approach towards spectroscopy.
2. Students will be able to understand the static properties of nuclei, nuclear force and nuclear models.
3. Students will apply the knowledge gained in atomic and molecular spectroscopy as well as to understand classical/Quantum description of electronic, vibrational and rotational spectra**.**

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit-I: Atomic Physics

Fine structure of hydrogenic atoms, Mass correction, spin-orbit term, Darwin term, Intensity of fine structure lines, Effect of magnetic and electric fields: Zeeman, Paschen-Bach and Stark effects, The ground state of two-electron atoms, perturbation theory and variational methods, Many-electron atoms, Central Field Approximation-LS and JJ coupling schemes, Lande interval rule, The Hartrec-Fock equations. The spectra of alkalis using quantum defect theory, Selection rules for electric and magnetic multipole radiation, Auger process.

Unit-II: Molecular Structure

Born-Oppenheimer approximation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Spectroscopic terms, Centrifugal distortion, Electronic structure-Molecular symmetry and the states, Molecular orbital and valence bond methods for H_2^+ and H_2, Basic concepts of correlation diagrams for heteronuclear molecules.

Unit-III: Molecular Spectra

Rotational spectra of diatomic molecules-rigid and non-rigid rotors, isotope effect, Vibrational spectra of diatomic molecules, harmonic and anharmonic vibrators, Intensity of spectral lines,

dissociation energy, vibration-rotation spectra, Electronic spectra of diatomic molecules-vibrational structure of electronic transitions, Rotational structure of electronic bands, Intensities in electronic bands-The Franck-Condon principle, The electron spin and Hund's cases, Raman Effect, Electron Spin Resonance, Nuclear Magnetic Resonance.

Unit-IV: Lasers

Life time of atomic and molecular states, Multilevel rate equations and saturation, Coherence and profile of spectral lines, Laser pumping and population inversion, He-Ne Laser, Solid State laser, Free-electron laser, Non-linear phenomenon, Harmonic generation, Liquid and gas lasers, semiconductor lasers.

Books Recommended:

1. Physics of Atoms and Molecules by B. H. Bransden and C. J. Jochain (2nd Ed., Pearson Education, 2003).
2. Atomic Spectra and Atomic Structure by G. Herzberg (Dover Publications, 2003).
3. Molecular Spectra and Molecular Structure by G. Herzberg (Van Nostrand, 1950).
4. Atoms, Molecules and Photons by W. Demtroder (Springer, 2006).
5. Fundamentals of Molecular Spectroscopy by C. N. Banwell (McGraw Hill, 1983)
6. Basic atomic & Molecular Spectrocopy by J. M. Hollas (Royal Society of Chemistry, 2002).
7. Principles of Lasers by O. Svelto (5th Ed., Springer, 2010).
8. Laser Spectroscopy by W. Demtroder (3rd Ed., Springer, 2003).
9. Molecular Quantum Mechanics by P Atkins & R. Friedman (Oxford Univ. Press, 2005).
10. Quantum Chemistry by I. N. Levine.

SEMESTER-IV

PHY-443 (i) Nano Physics (Optional)

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
Students will make the students to understand the various concepts of nanosized materials, their morphology, nomenclature and classifications along with different physical and chemical approaches used for their synthesis as well as their applications.

Note:

The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Introduction and Synthesis

Free electron theory and its features, Idea of band structure of metals, insulators and semiconductors, Density of state in one, two and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap, Examples of nanomaterials, Top down and bottom-up approaches, Physical and chemical methods for the synthesis of nanomaterials with examples.

UNIT-II: Characterization Techniques for Nano-Materials

Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photoluminescence peaks, variation in Raman spectra of nano-materials, photoemission and X-ray spectroscopy, magnetic resonance, microscopy: transmission electron microscopy, scanning probe microscopy.

UNIT-III: Quantum Nanostructures

Introduction to quantum wells wires and dots, preparation using lithography, Size and dimensionality effects: size effects, conduction electrons and dimensionality, potential wells, partial confinement, properties dependent on density of states, surface passivation and core/shell nanoparticles, Nanostructured semiconductors and films, single electron tunneling, Application: Infrared detectors, Quantum dot Lasers.

UNIT-IV: Carbon Nanostructures

Carbon molecules: nature of carbon bond, new carbon structures, Carbon clusters: small carbon clusters, structure of C60, alkali doped C60, Carbon nanotubes and nanofibres: fabrication, structure, electrical properties, vibrational properties, mechanical properties, Application of carbon nanotubes: field emission and shielding, computers, fuel cells, chemical sensors, catalysis.

Books Recommended

1. Thin Film fundamentals by A. Goswami, New age International, 2007
2. Introduction to Nanotechnology by Charles P. Poole Jr. and Franks J. Qwens, Wiley, 006.
3. Quantum Dot Heterostructures by D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley), 1998.
4. Nanoparticles and Nanostructured Films–Preparation, Characterization and Application by J.H. Fendler (Wiley), 1998.
5. Physics of Semiconductor Nanostructures by K.P. Jain (Narosa), 1997.
6. Physics of Low-Dimension Semiconductors by J.H. Davies (Cambridge Univ. Press) 1998.
7. Advances in Solid State Physics (Vo.41) by B. Kramer (Ed.) (Springer), 2001.
8. Nanotubes and Nanowires by CNR Rao and AGovindaraj-Royal Society of Chemistry,2005.
9. T. Pradeep, Nano-The Essentials, McGraw Hill Companies.

SEMESTER-IV

PHY-443 (ii) Advanced Electronics (Optional)

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. Students will build up the concept of integrated circuits and its application in the electronics and communications.
2. Students will be given chance to fabricate of Integrated Devices, Combinational logic design using IC, Digital Communication Pulse-Modulation Systems, Microwave Devices and Communications

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit I: Analog and Digital System

Analog Computation, Active Filters, Comparators, Logarithmic and Anti–Logarithmic Amplifiers, Sample and Hold Amplifiers, Waveform Generators, Square and Triangular Wave Generators, Pulse Generators, Read only Memory (ROM) and Applications, Random Access Memory (RAM) and applications, Digital to Analog Converters, Ladder and weighted type Analog to Digital Converters, Counter type, Successive Approximation and Dual Slope Converters, Application of Digital to Analog converter (DACs) and Analog to Digital Converter (ADCs).

Unit II: Digital Communications

Pulse-Modulation Systems: Sampling theorem- Low pass and Band pass Signals, PAM, Channel Bandwidth for a PAM signal, Natural sampling, Flat-Top sampling, Signal recovery through Holding, Quantization of signal, Quantization, Differential PCM, delta Modulation, Adaptive Delta Modulation, CVSD.

Digital Modulation techniques: BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK.

Unit-III: Microwave Devices and Communications

Klystron amplifiers, Velocity Modulation, Basic principle of two Cavity Klystron, Reflex klystron, Traveling Wave Tubes (TWT), Transferred Electron Devices (Gunn Diode), Tunnel Diode, IMPATT Diode, TRAPATT Diode.

Microwave Communications: Advantages and Disadvantages of Microwave Transmission, Propagation of microwaves, Atmospheric effects on propagation, Fresnel zone problem, Ground reflection, Fading sources, Detectors, Components, Antennas used in MW Communication Systems.

Unit-IV: Fabrication of Integrated Devices

Thin film Deposition Techniques; Vacuum pumps and gauges pumping speed, throughout Effective conductance control chemical vapor Deposition (CVD), MOCVD, PEMOCVD (plasma enhanced chemical vapour deposition)

Physical vapor Deposition: Thermal Evaporation, Molecular Beam Epitaxy (MBE), Sputtering and Laser Ablation, Lithography, Etching and Micro-Machining of Silicon, Fabrication of integrated circuits and integrated micro- electro-mechanical–Systems (MEMS).

Recommended Books:

1. Integrated electronics - MuIlman & Halkias.
2. Microprocessor and Interfacing - D. V Hall.
3. Theory and Application of Micro Electronics - S.K. Gandhi.
4. Micro Electronics - Millman & Grabel.
5. Digital Computer Electronics - AP. Malvino.
6. Atwater, "Introduction to Microwave Theory", McGraw Hill, 1962.
7. M.L. Sisodia and G.S. Raghuvanshi, "Microwave Circuits & Passive Devices", New Age International, 1988.
8. R. E. Collin, "Foundations of Microwave Engineering", McGraw Hill, 2001.
9. H.A. Watson, "Microwave Semiconductor Devices and Their Circuit Applications", 1969.

SEMESTER-IV

PHY-443 (iii) Advanced Nuclear Physics (Optional)

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:

1. Students will be able to understand structure and properties of nuclei, radioactive decay and different types of nuclear reactions.
2. Students will be able to understand quantum behavior of atoms in external electric and magnetic fields.
3. Students will be able to compare various nuclear models and properties of the nucleus.
4. Students will be able to understand nuclear forces, their dependence on various parameters, nuclear reactions and their properties.

Note:

The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT –I: Angular Momentum Theory

Angular momentum coupling: coupling of two angular momenta, coupling of three angular momenta, coupling of four angular momenta Racah coefficients, Tensors and reduced matrix elements of irreducible operators, Product of tensor operators, Application: Spherical harmonics between orbital angular momentum states, Spin operator between spin states, Angular momentum J between momentum states, Matrix elements element of compounded states and Matrix elements between angular momentum coupled state.

UNIT –II: Nuclear Decays

Decay widths and lifetimes, Alpha Decay: General Properties and theory of alpha decay, Barrier penetration of alpha decay, alpha decay spectroscopy Spontaneous fission decay Beta Decay: General Properties, Neutrinos and Antineutrinos, the Fermi theory of beta decay, Angular momentum and selection rules of beta decay, electron capture, beta spectroscopy, Gamma decay, reduced transition probabilities for gamma decay, Weisskopf units for gamma decay.

UNIT –III:

The Fermi gas model, The one body potential General properties, The harmonic oscillator potential separation of instrinsic and centre-of-mass motion, the kinetic energy and the harmonic oscillator, Conserved quantum numbers, angular momentum, parity and isospin, Quantum number for the two nucleon system, two proton or two neutron, and proton and neutron. The Hartree Fock Approximation Properties of single Slater determinants, Derivation of the Hartree-Fock equations, examples of single particle energies, Results with Skyrme Hamiltonian: Binding energy, single particle energies, Rms charge radii and charge densities.

UNIT –IV: The Shell Model

Ground state spin of nuclei, Static electromagnetic moments of nuclei, Electromagnetic transition probability on shell model, Exact treatment of two-nucleons by shall model, two-nucleon wave function, matrix elements of one-body operator and two-body potential, Shell model digonalization, Configuration mixing, relationship between hole state and particle state, State of hole-particle excitation and core polarization, Seniority and fractional percentage by second-quantization technique.

Books Recommended:

1. M.K. Pal Theory of Nuclear Structure, Affiliated East-West, Madras-1992.
2. Y. R. Waghmare, Introductory Nuclear Physics, Oxford-IBH, Bombay, 1981.
3. K. L. G. Heyde, The Nuclear Shell Model, (Springer-Verlag, 1994)
4. R. D. Lawson, Theory of the Nuclear Shell Model, (Clarendon Press, 1980).
5. A. R. Edmonds, Angular Momentum in Quantum Mechanics, (Princeton University Press, 1957
6. D. M. Brink and G. R. Satchler, Angular Momentum, (Clarendon Press, Oxford, 1968).
7. R. D. Lawson, Theory of the Nuclear Shell Model, (Clarendon Press, 1980)
8. D. Vautherin and D. M. Brink, Phys. Rev. C 5, 626 (1972)
9. T. R. H. Skyrme. Philos. Mag. 1, 1043 (1956); Nucl. Phys. 9, 615 (1959); 9, 635 (1959)
10. W. Kohn and L. J. Sham, Phys. Rev. 140 A1133 (1965).
11. P. J. Brussaard and P. W. M. Glaudemans, Shell Model Applications in Nuclear Spectroscopy, (North Holland, 1977).
12. A. de Shalit and I. Talmi, Nuclear Shell Theory, (Academic Press, 1963).

SEMESTER-IV

PHY-444 (i) Experimental Techniques in Physics (Optional)

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. Upon completion, students should be able to describe and explain the working principles of the various techniques.
2. Students will be able to identify the strength and limitation of each technique, therefore, choose the right technique for characterization of properties.
3. Students will be able to know the operational details and interpret the data obtained by the techniques.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT –I: Thin Film Deposition Technology

Thermal evaporation, general considerations and evaporation methods, Cathodic sputtering – sputtering process, glow discharge sputtering, sputtering variants and low pressure sputtering. Chemical methods – electro deposition and chemical vapour deposition.

UNIT-II: Diffraction Techniques

Principal, Instrumentation, working and applications of X-ray diffraction, Neutron diffraction, Electron diffraction, Diffraction data analysis.

Thermal analysis: Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Universal Tensile Testing.

UNIT-III: Microscopic Techniques

Basic concepts, Instrumentation, working and Applications of Optical Microscopy, Scanning Electron microscopy (SEM), Field Emission Scanning Electron Microscopy (FESEM), Energy Dispersive X-Ray spectroscopy (EDS), Transmission Electron Microscopy (TEM), Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM).

UNIT-IV: Spectroscopic Techniques

(Basic concepts, Instrumentation & working, Applications): UV-Visible absorption spectroscopy, X-ray photoelectron spectroscopy, Raman spectroscopy, Infrared spectroscopy, Fourier Transform Infrared spectroscopy, Luminescence spectroscopy, Atomic absorption spectroscopy, Impedance spectroscopy, Dielectric Spectroscopy, Mass spectroscopy, Mossbauer spectroscopy.

Books Recommended:

1. Materials Characterization Techniques 1st Edition, Kindle Edition, by Sam Zhang, Lin Li , Ashok Kumar, CRC Press.
2. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Yang Leng, Wiley.
3. Instrumentation: Devices and Systems, C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata McGraw Hill Publishing Co. Ltd.
4. Instrumental Methods of Chemical Analysis, G. Chatwal and S. Anand, Himalaya Publishing House
5. Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth Heinemann (1992)
6. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001 - Science - 664 pages)
7. Vacuum Science and Technology by V.V. Rao, T.B. Gosh, K.L. Chopra, Allied Publishers.

SEMESTER-IV

PHY-444 (ii) Opto-Electronics (Optional)

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. After the completion of course, knowledge about modulation of light, LEDs, Lasers, and Photodetectors will be imparted for fiber-optic communication.
2. Students will be able to explain key concepts in quantum and statistical mechanics relevant to physical, electrical and optoelectronic properties of materials.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

UNIT-I: Injection Luminescence
Recombination processes, the spectrum of recombination radiations, Direct and Indirect band gap Semiconductors, The Internal Quantum Efficiency, The External Quantum Efficiency
The Basic Principles of Laser Actions: spontaneous and stimulated emission and absorption, the condition for the laser action, Types of laser, Semiconductor lasers.

UNIT-II: Theory of Laser Action in Semiconductors
Condition for gain, The threshold conditions for oscillations, rates of spontaneous and stimulated emission , effect of refractive index, calculation of the gain coefficients, relation of the gain coefficient to current density.
Semiconductor Injection Laser: Efficiency, Stripe geometry LED materials, commercial LED materials, LED construction, Response time of LED's, LED derive circuitry.

UNIT-III: Optical Detectors
Introduction, Device types, Optical Detection. Principles, Absorption, quantum efficiency, Responsively, Long wavelength cut off, Photoconductive Detectors, Characteristics of particular photoconductive materials, Solar cell, Holography and its applications, Liquid crystal displays The Optical Fiber, Multimode and Single Mode Fibers, Glass Fibers, Plastic Optical Fibers, Fiber-Optic Bundle, Fabrication of Optical Fibers, Preform fabrication, Fiber Fabrication, Free Space Optics.

UNIT-IV: Junction Detectors
Detectors performance parameters Semiconductors p-i-n diodes, General Principle, quantum efficiency, Materials and design for p-i-n photodiodes, Impulse & frequency response of p-i-n photodiodes, Avalanche photodiodes detectors, The multiplication process, Avalanche photodiodes (APD) design, APD bandwidth, phototransistors.

Books Recommended:

1.Optical communication systems. John Gowar (Prentice Hall of India Pvt.Ltd.New Delhi.
2.Optical fibre communications-Principles and practice John.M.Senior.Prentice Hall International.
3.Optoelectronics-An Introduction(Second edition) J.Wilson. J.F.B Hawkes Prentice Hall International.
4.S.M.Sze Physics of the semiconductor devices. 2nd edition (1983) Wiley Eastern Ltd.
5 Fiber Optics And Lasers -The Two Revolutions Ajoy Ghatak and K Thyagarajan.

SEMESTER-IV

PHY-444 (iii) Nuclear Technology (Optional)

Credits: 4
Total Marks: 100
(IA: 40+ESE: 60)
Time-3 Hours

Learning Outcomes:
1. Upon completion of the course, students can define the basic elements of nuclear power production and technology.
2. Students can also describe different elements of nuclear power technology deployment such as safety, environmental and health related issues.

Note:
The question paper for the final examination will consist of five sections-A,B,C,D & E. Sections A,B,C, D will have two questions each from the corresponding units I,II,III & IV of the syllabus. Section E will be compulsory and will have short answer type questions consisting of six parts of two marks each covering the whole syllabus. Each question will be of 12 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Unit-I: Detectors and Instrumentation

Introduction, Gas detectors: ionization chamber, proportional counter, and Geiger-Mueller counter, Scintillation counters, Semiconductor Detectors, Neutrons detectors.

Particle Accelerators: Classification and performance characteristics of accelerators, Ion sources, Electrostatics accelerators, Cockroft – Walton generator, Cyclotron, Synchro-cyclrotron, Betatron, Electron and proton synchrotron, Microtron, Linear accelerator.

Unit-II: Biological Effects of Radiation

Initial interactions, Dose, dose rate and dose distribution, Damage to critical tissue, Human exposure to radiation and Risk assessment.

Industrial and Analytical Applications: Industrial uses:-Tracing, Gauging, material modification sterilization, food preservation, Neutron activation analysis, Rutherford backscattering, particle induced X-ray Emission Accelerator Mass spectroscopy

Unit-III: Nuclear Medicine

Projection Imaging: X-Radiography and the Gamma Camera, Computed Tomography, Positron Emission Tomography (PET), Magnetic resonance Imaging (MRI), Radiation Therapy.

Mossbauer Spectroscopy: Resonant absorption of gamma rays, the Mossbauer effect, Application: nano material spectroscopy and nuclear spectroscopy.

Unit-IV: Nuclear Energy Power from Fission

Characteristic of fission, The chain Reaction in a thermal fission reactor, reactor operation, commercial thermal reactions, the breeder reactor technology, accelerator driven systems, Indian nuclear energy programme.

Power from Fusion: Thermonuclear reaction and energy production, Fusion in hot medium, progress towards fusion power, fusion in early universe, stellar burning The pp chains, Beyond hydrogen burning, and nucleosynthesis: Production of light elements (upto Fe), Production of the heavy elements – supernovae, Lawson criteria, Fundamentals of inertial confinement fusion, Fundamentals of magnetic confinement method, Present status of fusion reactor technology.

Books Recommended:

1. Krane - Introductory Nuclear Physics. Covers most of the course in variable level of detail.
2. Leo - Techniques for Nuclear and Particle Physics Experiments. A lot of practical detail.
3. Murray - Nuclear Energy. Good general text on fission and fusion.
4. Bowers & Deeming - Astrophysics I (Stars). Covers solar nuclear physics.
5. Roth &Poty - Nuclear Methods of Dating. For radiocarbon and geological dating.
6. Webb - The Physics of Medical Imaging, 1988. Covers the nuclear imaging methods in adequate detail.

SEMESTER-IV

PHYMS-445

Credits= 04

M.Sc. Research Project/Seminar

All the M.Sc. Physics Students will do a supervised Physics Project/seminar in IV Semester. Department considers it an important culmination of training in Physics learning and research. This project/seminar supervised may be taken from **Theoretical Physics, Experimental Physics and other current issues**.

The project will aim to introduce student to the basics and methodology of research in physics, which is done via theory, computation and experiments either all together or separately by one of these approaches. It is intended to give research exposure to students at M.Sc. level itself. Students may also get the opportunity to participate in some ongoing research activity in any institution.

Students will be allocated to teachers in groups and how to prepare for project/seminar will be discussed accordingly. Students will be allotted a topic by the teacher may be in the end of sem-III or at the start of Sem-IV. The topic for presentation for project/seminar may be from the syllabus or relevant to the syllabus of the program. During the presentation being given by a student, all the other students of his/her group will attend the Seminar and will do the same. The assessment/evaluation will be done by the teacher. However, Head of Department and other faculty members (external/ internal) will also be present in the Seminar, ask questions and give their suggestions. This is a turn wise continuous process during the semester and each student will give minimum two presentations in a Semester before the final presentation before external as well as internal examiner.

For the evaluation, the following criteria will be adopted,

(a) Attendance in Two presentations in Project/Seminars and interaction during the work plan/framework: 10 Marks

(b) Knowledge/work done of Subject along with Q/A handling during course work: 10 Marks

(c) Presentation and Communication Skills during two seminars: 20 Marks

(d) Overall Presentation about the work done/results (in presence of External as well as Internal examiners): 60 Marks.

- The students will be allotted M.Sc. IV Semester project/seminar in consultation with their teachers well in time. To develop team spirit and group learning, students will be allotted projects in groups of three to four students but not more than four students in any case.
- Students will be informed about their respective groups (three/four students per group) which will be formed by inviting applications from the students who want to together as a group in the office of Physics Department, after due recommendation from the supervisor under whose supervision they wish to work along with a tentative title/topic.
- Students can choose topics from the following major fields or any other field decided from time to time for which department has the faculty and facilities.
- Students will discuss the topic with the supervisors and submit a one page typed abstract giving the plan of the same and start working on the project/seminar utilizing time for gathering resource material, references, setting up the experiments, understanding the theoretical frame work, and writing of the programs for computation if any. During the period of project students will have to give a seminar as per the schedule notified by the Department.
- Three copies of the project/seminar report will be required to be submitted in the office of the Physics department for final evaluation by the external examiner.
- Format of the project report as per the details given in below:

Title Page
M.Sc. Project/Seminar Report
On
Title of the Project/Seminar

Supervised by: Submitted by:
Name of the Group Name 1
Name 2
Name 3

SCHOOL OF BASIC AND APPLIED SCIENCES
MASTER OF SCIENCE IN PHYSICS (M.Sc. Physics)
Session
Month Year

Page 2

(Preferably on (Guide's) letter head)

Certificate

This is to certify that the project entitled "**Title of Project/Seminar**" aimed at "Project/Seminar purpose" was worked upon by the following students under my supervision at Physics Lab in the Department of Master of Science in Physics, H.P. Technical University, Hamirpur.

Name 1 with signatures
Name 2 with signatures
Name 3 with signatures

It is certified that this is a live project/Seminar done by the team and has not been submitted for any degree.

Chairman Name of Guide

Page 3

Acknowledgements

Page 4

Preface

Page 5

Contents

Page 6

Abbreviations used

Page 7

List of Tables

Page 8

List of Graph and figures

Page 9

Introduction

Chapter 1
Chapter 2
Chapter 3
……..
Concluding remarks

End of Report

Appendices
Source code and other relevant appendices
Bibliography /References.

Instructions for the Formatting and Presentation of Project/Seminar Report

The following instructions be strictly adhered to while formatting the Project/Seminar Report.
Top margin = 2.54 cm
Bottom margin = 2.54 cm
Left margin = 3.17 cm
Header and Footer = 3.17 cm
Page Size = 1.25 cm (from edge)
Font = Times new Roman
- Body test size……... 12pt
- Chapter headings …… 18 pt Bold
- Section heading ……16 ptBold
- Sub Section heading ……14 pt Bold

Header and footers
- Header …… Chapter Name
- Footer…….. Page number

Spacing before and after body text paragraph 6 pt uniform
Spacing before section headings Zero
Spacing after section headings 12
Line spacing 1.5 lines
Tables……Centered, captions must.
Diagrams……Centered, captions must, No text around Diagrams

Page Numbering scheme for entailing chapters…. Roman Numbers
Page Numbering scheme for entailing pages of chapters ….. Arabic
The pages starting from Certificate to list of graph and figures must be enlisted in chronological sequence using Roman Numbers.
Final Project report must be - Hard Bound
- Rexene Covered
- Golden text to be used on cover
- Print details on side strip also in text book format.

Paper to be used
Bond paper

Total Number of copies to be submitted along with soft copy on a CD 4 Copies

Last Date for Submission of Project/Seminar Report

Last date for submission of project report shall be one month before or after the last theory paper examination of IV Semester for regular students.