HIMACHAL PRADESH TECHNICAL UNIVERSITY
HAMIRPUR-177001 (INDIA)

SCHOOL OF BASIC AND APPLIED SCIENCES

SYLLABUS

FOR

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

(Two Years Programme)
(Spread Over Four Semesters)

CREDIT DISTRIBUTION FOR POST-GRADUATE PROGRAMS UNDER CHOICEBASED CREDIT SYSTEM (CBCS) BY UGC:

Sr. No.	School	Program	Core credits	DS/ID Elective credits	Foundation Courses credits	Total Credits	Marks
1	School of Basic and Applied Sciences	Master of Science in Physics	Sem I: 18 Sem II: 18 Sem III: 20 Sem IV: 08 = 64	ID: (Sem III: 04) DS: (Sem IV: 08+04) =16	Sem I: 04 Sem II: 04 =08	64+16+08 **=88**	Sem I: 600 Sem II: 600 Sem III: 600 Sem IV: 500 **= 2300**

Legend:

L Lecture
T Tutorial
P Practical
IA Internal Assessment
CT Class Test-Theory (Mid Semester Test-I & II)
CT Class Test-Practical (Mid Semester Test & Viva-Voce)
TA Teacher's Assessment-Theory (Assignment(s)/MCQs, Attendance)
TA Teacher's Assessment-Practical (File Work, Lab performance, Attendance)
ESE End Semester Examination
SD Skill Development
HM Human Making
IDE Interdisciplinary Elective
DSE Discipline Specific Elective

SCHOOL OF BASIC AND APPLIED SCIENCES

SYLLABUS

FOR

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

(Two Years Programme)
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FIRST SEMESTER

SYLLABUS SCHEME

Under Choice Based Credit System

(Effective from the Academic Session 2018-19)

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	General Physics Laboratory	-	-	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**

*__Skill Development-I:__ Scientific writing and Presentation

****Human Making-1:** Vedic Concepts of Physics

SEMESTER-I PHY-411

MATHEMATICAL PHYSICS-I

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

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

Complex Variables: Introduction Cauchy Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals. Dispersion relation.

UNIT -II

Delta and Gamma Functions: Dirac delta function. Delta sequences for one dimensional function, properties of delta function, gamma function, factorial notation and applications. Beta function.

UNIT -III

Differential Equations: Partial differential equations of theoretical physics, separation of variables, singular pints, series solutions, second solution.

UNIT -IV

Special Function: Bessel function of first and second kind, generating function, integral Representation and recurrence relations for Bessel's functions of first kind, orthogonally. Legendre function: generating function, recurrence relations and special properties, orthogonally. Various definitions of Legendre polynomials, Associated Legendre functions: recurrence relations, parity and orthogonlity. Hermite functions. Lagurerre function.

Books Recommended:

1. Mathematical methods for Physicists: G. Arfken and H.J. Weber (Academic Press, San Diego) (sixth edition) (2005)
2. Group Theory for Physicists: A.W. Joshi (Wiley Eastern, New Delhi) (2005)
3. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co. Kolkata) (1961).
4. A First Course in Computational Physics: P.L. Devries (Wiley, New York) (1994).
5. Matrices and Tensors in Physics: A.W. Joshi (Wiley Eastern, New Delhi) (2002).
6. Mathematical Physics: P.K. Chatopadhyay (Wiley Eastern, New Delhi) (2005)
7. Introduction to Mathematical Physics: C. Harper (Prentice Hall of India, New Delhi) (2004).
8. "Mathematical Physics" Rajput B.S. ,PragatiPrakashan, Meerut,2005.
9. "Advanced Engineering Mathematics", Kreyszig E. , 8th Ed., Jophn Wiley & Sons, New York, 2001.

SEMESTER-I PHY-412

CLASSICAL MECHANICS

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

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.

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

Note:

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

Unit-I

Linear Vector Space and Matrix Mechanics: Vector spaces, Sehwarz inequality, Orthonormal basis. Schmidt orthonormalisation method, Operators, projection operator.Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators. Dirae's bra and ket notation, commutators, Simultaneous eigenvectors.Postulates of quantum mechanics, unercrtainly relation.Harmonic oscillator in matrix mechanics.Time development of states and operators.Heisenberg and Schroedinger representations. Exchange operator and identical particles.

UNIT-II Angular Momentum: Angular part of the Schroedinger equation for a spherically symmetric potential, orbital angular momentum operator, Eigenvalues and eigenvector of L^2 and L_z, Spin angular momentum. General angular momentum, Eigenvalues and eigenvectors of J^2 &J_z. Representation of general momentum operator.Addition of general angular momentum, C.G. co-efficients.

UNIT-III

Stationary State Approximate Methods: Non- Degenerate and degenerate perturbation theory and its application to anharmonic oscillator, Variational method with application to the ground states of harmonic oscillator, hydrogen atom, helium and other simple cases.

UNIT-IV

Time Dependent Perturbation: General expression for the probability of transition forms one state to another. Constant and harmonic perturbations.Fermi's golden rule and its application to radiative transition in atoms. Selection rules for emission and absorption of light.

Books Recommended:

1. Quantum Mechanics: M.P. Khanna ,(HarAnand, New Delhi (2009)
2. A text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) (2004).
3. Quantum Mechanics: V.K Thankappan (New Age, New Delhi)(2005).
4. A Ghatak and S Lokanathan, Quantum Mechanics: Theory and Applications, 5th edition, Macmillan India, New Delhi (2005)
5. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi) (1998).
6. Quantum Physics: S. Gasiorowicz (Wiley – India Edition) (2009).
7. Modern Quantum Mechanics : (J.J. Sakurai (Pearson –Education, India).(2009)
8. Quantum Mechanics: Leonard L Schiff, McGRAW Hill Book Company Inc

SEMESTER-I PHY-414

CLASSICAL ELECTRODYNAMICS

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

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 and Magnetostatics:
Vector analysis, differentiation and integration, Dirac's delta function representation and use.
Scalar and vector potentials. Multiple expansion of Scalar potential due to a static charge distribution.Vector potential due to a stationary current distribution.

Unit-II
Maxwell's theory and Radiation
Maxwell's equations; charge, energy and momentum conservation (Poynting's vector and Maxwell's stress tensor) Electromagnetic fields and wave solution.
Inhomogeneous wave equations and their solutions; Radiation from localised sources and multipole expansion in the radiation zone.

Unit-III:
Radiation from moving point charges
Lienard- Wiechert potentials, Fields due to a charge moving with uniform velocity, Fields due to an accelerated charge, Radiation at low velocity Larmor's formula and its relativistic generalization, Radiation when velocity (relativistic) and acceleration are parallel, Bremsstrahlung Radiation when velocity and acceleration are perpendicular, Synchrotron radiation, Cherenkov radiation, Radiation reaction, Problem with Abraham-Lorentz formula, Limitations of classical theory.

Unit-IV
Relativistic formulation of electrodynamics
Introduction to special relativity: Postulates of Einstein, Geometry of relativity, Lorentz transformations. Relativistic mechanics: Proper time, proper velocity, Kinematics and dynamics. Four vector notation Electromagnetic field tensor, covariance of Maxwell's equations.

Books Recommended:

1 J. Marion and M. Heald: Classical electromagnetic radiation, Saunders college publishing.
2 L. Landau and E. Lifshitz: Classical theory of fields, Pergamon Press.
3 J. Jackson: Classical electrodynamics, Wiley international.
4 M. Schwartz: Classical electromagnetic theory, Dover publication

Lab Course

PHY-41L-I GENERAL PHYSICS LABORATORY

Credits: 2

Total Marks: 100

(IA: 40+ESE: 60)

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

Internal assessment for the laboratory 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.

1. To study the dependence of energy transfer on the mass ratio of colliding bodies. Using air track.
2. To study the dependence of frequency of normal modes and their difference in a couples oscillator on the coupling mass
3. To verify the law of conservation of linear momentum in collision using air track
4. To obtain the potential energy curve due to magnet-magnet interactions using air track.
5. To study oscillations in a rectangular potential well, using air track.
6. To determine Planck's constant using photocell.
7. To find wavelength of given laser light using diffraction grating and carry out related studies.
8. To study the distributed capacity of given inductance coil.
9. To study the characteristics of phototransistor.
10. To find conductivity of given semiconductor crystal using four probe method.
11. To determine the Hall coefficient for given semi-conductor and study its field dependence.
12. To determine the velocity of ultrasonic in given liquid. Using interferometer.
13. To study non-radiative transition in LED.
14. Zeeman effect experiment
15. Magnetic susceptibility of Para-magnetic liquids.
16. Velocity of light determination experiment

Books Recommended:

1. C.L. Arora Practical Physics S. Chand & company Ltd ,2009
2. S. P. Singh, Advanced Practical Physics Vol I & II, PragatiPrakashan, 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

Scientific Writing and Presentation

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

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.

Book:

1. Open Software and standard Open and Licensed software.

Credits Equivalent: *One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)*

SEMESTER-I PHY-HM-I

Vedic Concepts of Physics

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

Time-2 Hours

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 VaisheshikDarshan 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).

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SECOND SEMESTER

SYLLABUS SCHEME

Under Choice Based Credit System

(Effective from the Academic Session 2018-19)

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 Laboratory-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**

***Skill Development-II**

Entrepreneurship Development

****Human Making-II**

Human Values and Professional Ethics

SEMESTER-II PHY-421

MATHEMATICAL PHYSICS-II

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

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Unit-I

Laplace Transforms: Definition, Conditions of existence, Functions of exponential orders, Laplace transform of elementary functions, Basic theorems of Laplace transforms, Laplace transform of special functions, Inverse Laplace transforms, its properties and related theorems, Convolution theorem, Use of Laplace transforms in the solution of differential equations with constant and variable coefficients and simultaneous differential equations.

Unit-II

Fourier Series and Transform: Dirichlet conditions, Expansion of periodic functions in Fourier series, Complex form of Fourier series, Sine and cosine series, The finite Fourier sine and cosine transforms, Fourier integral theorem and Fourier transform, Convolution theorem for Fourier transforms.

Unit-III

Tensors: Introduction, definitions, contraction, direct product, Quotient rule. Pseudo tensors, Levi-Civita symbol, irreducible tensors, Non Cartesian tensors - metric tensor. Christoffel symbols, Covariant differentiation.

Unit-IV

Integral Equations: Definitions and classifications, Neumann series, Separable kernels, HilbertSchmidt theory. Green's function in one dimension.

Group Theory: 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. George Arfken“ Mathematical Methods for Physicists”, Academic Press, San Diego,U.S.A.
2. Rajput B.S. “Mathematical Physics” PragatiPrakashan, Meerut, 2005.
3. J. Mathews and R. L. Walker: Mathematical Methods of Physics (I. B. House Pvt.Ltd.).
4. A. W. Joshi: Vectors & Tensors (Wiley Eastern Limited).
5. A. W. Joshi: Elements of Group Theory (Wiley Eastern).
6. H. K. Dass: Mathematical Physics, Published by S. Chand Publisher

SEMESTER-II PHY-422

ELECTRONICS

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

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Unit-I

Operational amplifiers: Differential amplifiers-circuit configuration-Dual Input, Balanced Output, Differential Amplifier-DC analysis-AC analysis, Inverting and Non-Inverting Inputs, CMRR-constant current bias level translator. Block diagram of typical Op-amp-analysis, Open loop configuration, Inverting and Non-Inverting Amplifiers, Op-Amp with negative feedback-voltage series feedback –effect of feedback on closed loop gain, Input Resistance, Output Resistance Bandwidth and Output Offset Voltage, Voltage Follower, Practical Op-Amp Input Offset voltage-Input Bias Current-Input Offset current, Total Output Offset Voltage, CMRR frequency response, DC and AC Amplifiers, Summing, Scaling and Averaging Amplifiers, Instrumentation Amplifiers, Integrator and Differentiator.

Unit-II

Sequential logic: Flip flops, 1 bit memory, the RS flip flop, JK flip flop, JK master slave flip-flop, T flipflop, D, Flip-flop, Shift registers, synchronous and asynchronous counters, Cascade counters, Digital to analogue converters. Ladder and weighted register types, analog to digital converters, successive approximations and dual slop converters, application of DAC and ADC.

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.

Unit-III

Communication Systems: Amplitude modulation , generation of AM waves, demodulation of AM waves, 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).

Digital Modulation Techniques: Binary Phase-Shift Keying (BPSK), Differential Phase-Shift Keying (DPSK), Quadrature Phase-Shift Keying (QPSK), Phase-Shift Keying (PSK), Quadrature Amplitude Shift Keying (QASK), Binary frequency Shift Keying (BFSK), Frequency Shift Keying (FSK) , Minimum Shift Keying (MSK).

Unit-IV

Microwave Devices: 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, Loss in free space, Propagation of microwaves, Atmospheric effects on propagation, Fresnel zone problem, Ground reflection, Fading sources, Detectors, Components, Antennas used in MW Communication Systems.

Books Recommended:

1. Electronic devices and circuit theory: Robort Boylested and L. Nashdsky (PHI, New Delhi).
2. OP-Amps and linear integrated circuits: Ramakanth A. Gayakwad (PHI 2nd Edn).
3. Digital principles and Applications: A. P. Malvino and D. P. Leach (Tata Ma-Graw Hill).
4. Microprocessor architecture, programming and Application with 8085/8086, Ramesh S. Gaonkar (Wiley-Estern).
5. Microelectronics: Jacob Millman (Mc-Graw Hill Interna).
6. Optoelectronics: Theory and Practices: Edited by Alien Chappal (Mc Graw Hill).
7. Microwaves: K. L. Gupta (Wiley Ester New Delhi).
8. Advanced electronics communication systems: Wayne Tomasi (Phi Edn).
9. Fundamentals of microprocessors and Micro-computers: B. Ram. (Dhanpat Rao and Sons.).
10. Principles of communication systems: Taub and Schilling Goutam Saha Third Edition.

SEMESTER-II PHY-423

Statistical Physics

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

Note:

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Unit-I

Basics of Thermodynamics: Laws of thermodynamics and their consequences; Thermodynamic potentials, Maxwell relations; Chemical potentials, Phase equilibrium.

Statistical basis of thermodynamics: The macroscopic and the microscopic states, phase space, trajectories and density of states, Liouville's theorem, the principle of maximum entropy, contact between statistical mechanics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox.

Unit-II

Ensemble Theory: Micro canonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations.

Unit-III

Quantum Statistics of Ideal Systems: Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behavior of an ideal Fermi gas, discussion of heat capacity of a free electron gas at low temperatures, Pauli paramagnetism.

Unit-IV

Phase transitions: Type of phase transitions, first and second order phase transitions. Diamagnetism, paramagnetism and ferromagnetism, Ising model, mean-field theories of the Ising model in two and three dimensions, exact solution in one dimension. Landau theory of phase transition, Landau free energy for second and first order transitions.

Fluctuations: 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. Statistical Mechanics : S.K. Sinha (Tata McGraw Hill, New Delhi) (1990).
6. L. D. Landau and I. M. Lifshitz: Statistical Physics Third Edition (Part – I) (Pergamon).

SEMESTER-II PHY-424

Condensed Matter Physics-I

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

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

Lattice Vibrations: Genesis of elastic constants, elastic waves and velocities of waves in cubic crystals, experimental determination.Dispersion relation of mono-atomic and diatomic chains, frequency distribution function, Van-Hove singularities.Quantization of lattice modes, High temperature and low temperature specific heat of lattice.Inelastic scattering of neutrons by phonons and conservation laws.A harmonic crystal interaction, thermal expansion and Gruneissen parameter.Thermal conductivity; lattice thermal conductivity, Umklapp process.

Unit-II

Free Electron gas: Free electron gas in three dimensions, idea of periodic boundary conditions and density of states, concept of Fermi surface. Heat capacity of electron gas and its application in metals.Electrical and thermal conductivity of metals.Mathiessen's rule and experimental view point. Motion of free electrons in magnetic field and Hall effect. Boltzmann equation; electrical and thermal conductivity of metals and insulators, thermoelectric effects, Hall effect. Magneto resistance and phonon drag.

Unit-III

Energy Band Theory: Bloch theorem, electron in periodic potential and square well potential.Empty lattice approximation, concept of effective mass.Distinction between metals, insulators and semiconductors. Semiconductor: band gap, equation of motion, Zone schemes, construction of Fermi surfaces, electron hole and open orbits; Calculation of energy bands; tight binding method, Wigner-Seitz method, pseudo-potentials(qualitative only). Law of mass action in semiconductors, impurity conductivity and impurity states.Thermo-electric effect. Study and construction of Fermi surfaces by cyclotron resonance and de-Hass van Alphen effect.

Unit-IV

Superconductivity: Experimental survey, occurrence, Meissner effect, heat capacity, energy gap, microwave and infrared properties, isotope effect.Theoretical survey; Thermodynamics, London equation, coherence length, BCS theory (qualitative only), BCS ground state. Flux quantization in a superconducting ring, duration of persistent currents. Type II superconductors, vortex state, estimation of H_{c1} amd H_{c2}. Josephson tunneling, dc and a. c. Josephson effect, Macroscopic quantum interference.

Books Recommended:

1. Introduction to Solid State Physics: C. Kittel, VII Edition, (John Wiley and Sons).
2. Solid State Physics: N. W. Ashcroft and N. D. Mermin (H. R. W. International edition).
3. Physics of Solids: C. A. Wert and R. M. Thomson (McGraw Hill)
4. Solid state Physics: M A Wahab (2nd edition ,Narosa, New Delhi) (2006)
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) (1979

Lab Course

PHY-42L-II PHYSICS LABORATORY-II

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

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

Internal assessment for the laboratory 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.

1. Zener diode: Characteristics and voltage regulation.
2. Experiment on Uni-Junction Transistor and its applications.
3. Experiment on FET and MOSFET characterization and application as an amplifier.
4. Study of Operational Amplifier as integrator & differentiator
5. To study Registors
6. To study Counters
7. Basic Logic Gates, NAND and NOR, XOR, XNOR, combinational Logic
8. Flip-Flops: RS, JK/JK master slave, T and D.
9. Network Analysis-Thevenin and Norton's equivalent circuits
10. Study of clipping and clamping circuits.
11. A/D and D/A conversion
12. To Study the Half and full adder of binary numbers.
13. Multiplexers and Demultiplexers.
14. Addition, Subtraction, Multiplication & Division using 8085/8086
15 BCD to Seven Segment display
16. Fibre Optics communication
17. Modulation and demodulation: AM, FM, PAM.
18. Study of CRO.

Books Recommended:

1. C.L. Arora Practical Physics S. Chand & company Ltd ,2009
2. S. P. Singh, Advanced Practical Physics Vol I & II, PragatiPrakashan, 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. Computational Physics: An Introduction, R.C. Verma, P.K.Ahluwalia& K.C Sharma, New Age Pub. N.Delhi, 1999.

SEMESTER-II PHY-SD-II

ENTREPRENEURSHIP DEVELOPMENT

Credits: 2

Total Marks: 50

(IA: 20+ESE: 30)

Time-2 Hours

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-HM-II

HUMAN VALUES AND PROFESSIONAL ETHICS

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

Time-2 Hours

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 (2009). Business Ethics: Concepts & Cases, Cengage Learning.
2. Colin Fisher and Alan Lovell (2009). Business ethics and values: Individual, Corporate and International Perspectives, Prentice Hall.
3. Gaur R. R, R Sangal, G P Bagaria (2011). Human values and professional ethics (excel books).
4. Fernando A.C., (2009). Business Ethics: An Indian Perspective, Prentice Publications.
5. Nagarazan R.S. (2008). Professional ethics and Human values New Age International.
6. R R Gaur, R Sangal, G P Bhagaria, 2009, A Foundation Course in Value Education.

SCHOOL OF BASIC AND APPLIED SCIENCES

SYLLABUS

FOR

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

(Two Years Programme)
(Spread Over Four Semesters)

THIRD SEMESTER

SYLLABUS SCHEME

Under Choice Based Credit System

(Effective from the Academic Session 2018-19)

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 Laboratory-III	-	-	4	4	20	20	40	60	100
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 Issues

SEMESTER-III PHY-431

QUANTUM MECHANICS-II

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

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

Scattering Theory: Scattering Cross-section and scattering amplitude, differential and total cross-section, Green's functions in scattering theory, partial wave analysis, asymptotic behaviour of partial waves, phase shifts, scattering amplitude in terms of phase shifts, cross-sections, Optical theorem. Phase shifts and its relation to potential, effective range theory. Low energy scattering, Born approximation, its validity condition and application to Yukawa potential and other simple potentials.

Unit-II

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-III

Relativistic Klein- Gordon Equation: Generalization of the Schrodinger equation; Klein-Gordon equation, plane wave solutions, charge and current densities, interaction with electromagnetic fields, Hydrogen-like atom (to show it does not yield physical spectrum), Extension of Klein-Gordon equation to spin 1 particles.

Unit-IV

Relativistic Dirac Equation: Dirac Equation; relativistic Hamiltonian, probability density, expectation values, Dirac gamma matrices, and their properties, non-relativistic limit of Dirac equation. Covariance of Dirac equation, plane wave solution, Dirac equation for a particle in a central field.Fine structure of hydrogen atom, Spin-orbit coupling, Electron spin and magnetic moment, hyperfine structure of hydrogen atom.

Quantization of Wave Fields: The procedure for quantization of wave fields, quantization of non-relativistic Schrodinger Equation, second quantization, N-representation creation and annihilation operators.

Books Recommended:

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics (TMH)
2. A. S. Davydov, Quantum Mechanics (Pergamon).
3. L. I. Schiff, Quantum Mechanics (McGraw Hill).
4. J. D. Bjorken and S. D. Drell, Relativistic Quantum Mechanics (McGraw Hill).
5. N. Zettili, Quantum Mechanics- Concepts and Applications, Wiley, 2016
5. J. J. Sakurai, Advanced Quantum Mechanics (Addison Wesley).

SEMESTER-III PHY-432

NUCLEAR PHYSICS

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

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)

SEMESTER-III PHY-433

HIGH ENERGY PHYSICS

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

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

Kinematics of Scattering Interaction Picture, Scattering Matrix, Two and Three bodyphase space, Space- time symmetries, Invariance Principles, Parity, Intrinsic party, Partyconstraints on the S-Matrix for Hadronic Reactions, Time – Reversal Invariance,Principle of Detailed Balance, Nucleon – Nuclean Scattering Amplitudes, Unitarity constraints Internal symmetries, Selection Rules and Globally conserved QuantumNumbers, Isospin, Charge Conjugation, G- parity, CP and CPT Invariance.

Unit-II

Unitary Groups, Isospin and SU (2), SU (3), Particle Representation SU (3), U-spin, VspinIrreducible Representations of SU (3), Applications of Flavor SU(3), Mass Splittingin Flavor SU (3), Quark Model, Gell- Mann Okubo Mass Formula.

Unit-III

Weak Interactions, Classification of weak Interactions; Leptonic Semi- Leptonic andNon-Leptonic Decay, Tau- Theta Puzzle, Parity Violation in Weak Decays Selection Rules: $\Delta S = \Delta Q$ rule for Semileptonic Decays, $\Delta I = ½$ rule for hadronic decays.

Unit-IV

Universality of Weak Interactions, Fermi Theory of weak interactions, IntermediateVector – Boson Hypothesis, Helicity of Neutrino, Two Component Theory of Neutrino, K^oK^o Mixing and CP Violation, K^oK^o Regeneration.

Books Recommended:

1. A Modern Introduction to Particle Physics, Riazuddin and Fayyazudi.
2. Particle Physics, S. Gasiorowkz
3. Particle Physics : An Introduction, M. Leon (Academic Press).
4. Unitary Symmetry P. Carruthers.
5. Nuclear and Particle Physics W.E. Burcham and M. Jobes(Addision –Wisely)
6. Introduction to Nuclear and Particle Physics V.K. Mittal, R.C. Verma, & S.C. Gupta, PreniceHall of India (3rd edition: 2013)

SEMESTER-III PHY-434

Numerical Methods and Programming

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

Accuracy of approximate calculations: Absolute, relative and percentage errors, Relative error and the number of significant figures, General error formula, Error in a series approximation.

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.

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, Numerov method.

Partial differential equations: Elliptic, parabolic and hyperbolic equations and corresponding difference equations for each type. Applications: solution of Laplace equation, Poission Equation, and heat equation.

UNIT-IV

Programming: 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.

Books Recommended:

1. Rajaraman V. “Computer Programming in Fortran-90 and 95”, Prentice Hall of India Ltd., New Delhi.
2. Stephen J. Chapman,” Fortran 90/95 for Scientists and Engineers”, McGraw Hill Education
3. William Press, “Numerical Recipes in Fortran”, Cambridge University Press India Pvt Ltd.
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. Conte S.D. “Elementary Numerical Analysis”, Tata McGraw Hill Publishing Company, New Delhi.

Lab Course

PHY-43L-III PHYSICS LABORATORY-III

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

Note: Students are required to perform at least Eight experiments from Section A and at least Four experiments from section B.

Internal assessment for the laboratory 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.

Section-A

1. Kelvin double bridge: determination of low resistance.
2. Anderson bridge: determination of self-inductance.
3. Solar cell characteristics.
4. Ionization potential of mercury/Lithium.
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 based experiments using BASIC/ FORTRAN/C/C++/Mathematica

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 (Option)

Research Methodology

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 (Option)

Environmental 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

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.

SCHOOL OF BASIC AND APPLIED SCIENCES

SYLLABUS

FOR

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

(Two Years Programme)
(Spread Over Four Semesters)

FOURTH SEMESTER

SYLLABUS SCHEME

Under Choice Based Credit System

(Effective from the Academic Session 2018-19)

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	PHY445	M.Sc. Research Project	4			4	20	20	40	60	100
Total =			**16+4**			**20**	**100**	**100**	**200**	**300**	**500**

Discipline Specific Elective-I (Option)

(i) Nano Physics
(ii) Advanced Nuclear Physics
(iii) Advanced High Energy Physics

Discipline Specific Elective-II (Option)

(i) Characterization Techniques
(ii) Nuclear Technology
(iii) Nuclear and Particle Astrophysics

SEMESTER-IV PHY-441

CONDENSED MATTER PHYSICS - II

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

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

Defects and Diffusion in solids: Point defects: Schottky and Frenkel vacancies, Diffusion, Fick's law. Color centers, *F*-centers. Line defects (dislocation): Edge and Screw dislocation, Burger's vector, Slip, Planar (stacking) faults: Grain boundaries: Low angle grain boundaries.

Unit-II

Phase Diagrams and Phase Transformation: Definitions and Basic concepts: solubility limit, phase, microstructure, phase equilibria, one component phase diagrams, Binary phase diagrams: binary isomorphous systems, interpretation of phase diagrams, development of microstructure in isomorphous alloys and their mechanical properties, binary eutectic systems and development of microstructure in eutectic alloys, equilibrium diagrams having intermediate phases, eutectoid and peritectic reactions, congruent phase transformations, ceramic and ternary phase diagram, the Gibbs phase rule, Phase transformations: basic concepts, the kinetics of phase transformations, metastable versus equilibrium states, isothermal and continuous cooling transformation diagrams and tempered martensite.

Unit-III

Magnetic Properties: Langevin theory of diamagnetism, quantum theory of para-magnetism (rare earth, Hund's rule, Iron group ions). Crystal field splitting and quenching of orbital angular momentum. Cooling by adiabatic demagnetization of a paramagnetic salt.Nuclear demagnetization.Paramagnetic susceptibility of conduction electrons.Ferro and anti ferromagnetic order and molecular field theory. Exchange interaction, classical derivation of spin wave dispersion relations in ferro, anti-ferromagnetic systems and thermodynamic properties. Ferromagnetic domain, anisotropy energy and Block wall. Coercive force and hysteresis, magnetic bubble domains. Nuclear magnetic resonance and relaxation times. Ferro and anti-ferromagnetic resonance.

Unit-IV

Dielectric and Ferroelectric Properties: Polarization, macroscopic electric field, depolarization field, local electric field at an atom, Lorentz field, field of dipoles inside cavity. Dielectric constant and polarizability Claussius - Mosseti relation. Polarizability (electronic, ionic, dipolar). Classical theory of electronic polarizability, Ferro electric crystals and their classification. Polarization catastrophe, Landau theory of phase transition. Piezo- electricity, anti- ferro electricity, ferro- electric domains, ferro-electricity. Dielectric function of the electron gas, plasma optics and transparency of alkali metals, plasma oscillation in metals (plasmons).

Books Recommended:

1. Introduction to Solid State Physics: C. Kittel, VII Edition, (John Wiley and Sons).
2. Solid State Physics: N. W. Ashcroft and N. D. Mermin (H. R. W. International edition).
3. Physics of Solids: C. A. Wert and R. M. Thomson (McGraw Hill)
4. Solid state Physics: M A Wahab (2nd edition ,Narosa, New Delhi) (2006)
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) (1979

SEMESTER-IV PHY-442

ATOMIC AND MOLECULAR PHYSICS

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

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

Electronic spectroscopy of Atoms: Electronic wave function – atomic quantum numbers – hydrogen atom spectrum – Electronic angular momentum – Fine structure of hydrogen atom – Many-electron atoms – Lithium atom spectrum – angular momentum of many electron atoms – Term symbols – LS and JJ coupling – Spectrum of helium and alkaline earths – Equivalent and non-equivalent electrons – Zeeman effect – Paschen-Back effect – Stark effect – X-ray photoelectron spectroscopy.

Unit II

Aspects of Molecular Spectroscopy and Rotational spectroscopy Diatomic molecule – Molecular orbital theory (LCAO) – Shape of molecular orbitals (Morse Potential) – Born-Oppenheimer approximation – Regions of the electromagnetic spectrum – Width and intensity of spectral lines – Rotation of molecules – Rigid diatomic molecules – Intensity of line spectra – the effect of isotropic substitution – non-rigid rotator and their spectra – polyatomic molecules (linear and symmetric top molecules) – Technique and instrumentation of microwave spectroscopy.

Unit III

Vibrational Spectroscopy Energy of diatomic molecules – Simple Harmonic Oscillator – Anharmonic oscillator – Diatomic vibrating rotator – Vibration-Rotation spectrum of carbon monoxide – Breakdown of Born-Oppenheimer approximation –Vibrations and symmetry of polyatomic molecules – Influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) – Quantum and classical theory of Raman effect – pure rotational Raman spectra (linear and symmetric top molecules) – Raman active vibrations – Vibrational Raman spectra – Rotational fine structure – Vibrations of spherical tip molecules – Techniques and instrumentation of Infrared and Raman spectrometers.

Unit IV:

Electronic Spectroscopy of Molecules: Franck-Condon principle – Dissociation energy and their products – Rotational fine structure of vibronic transitions, Spectrum of molecular hydrogen – Change of shape on excitation – Chemical analysis by electronic spectroscopy – Re-emission of energy by an excited molecule.

Spin Resonance Spectroscopy: Nature of spinning particles – Spin and magnetic field interaction – Larmor precession – Relaxation time – Spin-spin relaxation – Spin–lattice relaxation - NMR chemical shift – Coupling constants – Coupling between nuclei – Chemical analysis by NMR – Exchange Phenomena - NMR for nuclei other than hydrogen - ESR spectroscopy – g-factor – Electron-Nucleus Coupling – Electron-Electron Coupling.

Books Recommended:

1 Spectroscopy (Atomic and molecular), G. R. Chatwal and S. K. Anand, Himalaya Publishing House, 2016.
2 Atomic spectra & atomic structure, Gerhard Hertzberg: Dover publication, New York.
3 Molecular structure & spectroscopy, G. Aruldhas; Prentice – Hall of India, New Delhi.
4 Fundamentals of molecular spectroscopy, Colin N. Banwell & Elaine M. McCash, Tata McGraw –Hill publishing company limited.
5 Atomic and Molecular Spectra: Rajkumar (Kedarnath Ramnath Prakashan, Meerut).

SEMESTER-IV PHY-443 (i) (Option)

Nano Physics

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

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 nanomaterials, 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.

SEMESTER-IV PHY-443 (ii) (Option)

Advanced Nuclear Physics

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

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 HartreeFock 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-443 (iii) (Option)

Advanced High Energy Physics

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

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

Symmetries and Conservation Laws, Noether's theorem, U(1) gauge invariance baryon and Lepton Number Conservation Global and Local Gauge Invariance, Spontaneous Breaking of Global gauge invariance.

Unit-II

Goldstone Bosons, Higgs Mechanism, Generalized Local gauge invariance, Ablian and Non Abelian gauge invariance, Weinberg- Salam Theory of Electroweak Unification , the matter fields, the gauge fields, The gauging of SU (2) XU (I),

Unit-III

The Vector Bosons, the fermion sector, Helicity States, Fermion Masses, Fermon Assignments in the electroweak model, Spontaneous Symmetry Break down, Fermion Mass Generation, the Color gauge theory of Strong interactions.

Unit-IV

SU (5) Grand Unified Theory, the generators of SU (5), The Choice of fermion representations Spontaneous Breaking of SU (5) Symmetry Fermion Masses and Mixing Angles, the Classic Predictions of SU(5) Grand Unified Theory Quark- lepton Mass Relations in SU(5).

Books Recommended:

1. Modern Elementary Particles Physics, G.L.Kane(Addison Wesley).
2. Gauge Theories of Strong, Weak and Electromagnetic Interactions C. Quigg (Addison-Wesley)
3. Grand Unified Theories Graham Ross (Addison Wesley)
4. Gauge theory of Elementary Particles Physics, P.P. Cheng and Ling Fong Li.
5. Gauge Field Theories, Paul H. Frampton (Addison Wesley)
6. Gauge Field theories J. Leite Lopes, Pergamon Press.

SEMESTER-IV PHY-444 (i) (Option)

Characterization Techniques

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

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 – electrodeposition 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).

UNIT-III

Microscopic Techniques: Basic concepts, Instrumentation, working and Applications of Optical Microscopy, Electron microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning probe microscopy-Scanning Tunneling Microscopy, Atomic Force Microscopy.

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, Mass spectroscopy, impedance 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) (Option)

Nuclear Technology

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

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

The interaction of radiation with matter: Introduction, Heavy charged particle interactions, electron interactions. Gamma rays interactions:- photoelectric effect, Compton scattering, pair production and attenuation. Neutrons interactions:-moderation, nuclear reaction and elastic and inelastic scattering.
Detectors and Instrumentation: Introduction, Gas detectors: ionization chamber, proportional counter, and Geiger-Mueller counter. Scintillation counters. Semiconductor Detectors, Neutrons detectors.

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, the reactor, reactor operation, commercial thermal reactions, the breeder reactor, accelerator driven systems.
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 (up to Fe), Production of the heavy elements – supernovae.

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 PHY-444 (iii) (Option)

Nuclear & Particle Astrophysics

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

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

The observational basis of Nuclear Astrophysics, The importance of the four fundamental interactions, A Brief Description of the Observed Universe, The Origin of the Universe: The Hadron Era, the Lepton Era, The Radiation Era; the Stellar Era: Stellar Evolution: the Hertzsprung- Russel Diagram, Evolution of Stars: The Chemical Composition of the Observable Universe, Techniques for Abundance Determination: The Direct and Indirect Methods; The Abundances of Elements in the Universe, The main Sequence Stars.

Unit-II

Thermonuclear and Nuclear Reactions in Stellar Interiors; Nuclear Reactions: Generalities; Nuclear Reaction Rates; Hydrogen burning: The Proton Proton chain or PPI Chain, the Proton chains with a He Catalyst or PP II and PP III Chains; The CNO Cycle, Helium burning, Hydrostatic C,O and Si Burning Explosive Nucleosynthesis in stars, Supernovae: the Fe Photodisintegration Mechanism, The Helium Flashes, the Novae Outbursts

Unit-III

Explosions of Supermassive Stars, The Explosive Nucleosynthesis Explosive Burning in H and he burning Zones, Explosive Nucleosynthesis in C,O and Si burning Zones, Formation of the heavy Elements, Abundances of the Heavy Elements- Processes of Neutron Capture, Neutron Capture Reactions. The S-process , the main Neutron Sources for the S-process, The S-process Nucleosynthesis; the r-process; The p- process: Weak Interaction Mechanism Spallation Reactions, thermonuclear Reactions.

Unit-IV

Nucleosynthesis of Light Elements, the Abundances of Light Elements, the Spattation Reaction, Production of Li, Be, B by the galactic Cosmic Rays , Light Element Production in Stellar interiors and Supernovae explosions Big Bang Nucleosynthesis; the Basic Assumptions, the Standard Model of the Universe, The Cosmdogical principle and the expansion of the Universe, thermal Equilibrium, The Radiation Era, Cosmological Limits on Neutrino Mass, Primordial Nucleosynthesis, Helium Production, Cosmological Bounds on Heavy Neutrinos, baryon Asymmetry of the Universe, The Baryon Number generation, the Cosmological Constant, The Inflationary Universe.

Books Recommended:

1. An Introduction to Nuclear Astrophysics, Jean Audouze and SylvteVaudair.
2. The Early Universe, E.W. Kolb and M.S. Turner (Addision – Wesley)
3. An Introduction to Modern Stellar Astrophysics D.A. Ostlie and B.W. Carroll, Addision Wesley (2007).

SEMESTER-IV

PHYMS-445

Credits= 04

M.Sc. Research Project

All the M.Sc. Physics Students will do a supervised Physics Project in IV Semester. Department considers it an important culmination of training in Physics learning and research. This project shall be a supervised collaborative work in **Theoretical Physics and Experimental Physics**. 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 and development of a laboratory experiment.

Following will be the modalities:

(i) Since lot of ground work including purchase of components/ equipments may be involved depending on the choice of the project, a strict schedule will be drawn and followed, to meet the deadline for submitting the project as laid down below.

(ii) The students wiil be allotted M.Sc. IV Semester project in consultation with their supervisors well in advance but not later than middle of third semester i.e. 31st oct to give students ample time to work on the allotted topics in consultation with their supervisors. 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.

(iii) 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 by 30th of September.

(iv) 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

(v) Students will discuss the topic with the supervisors and submit a one page typed abstract giving the plan of the same by 31st November along with the list of components etc. (for Experimental Project) needed for the project and start working on the project 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 chairman. The plan of work should include information about.

a) Gathering resource material
b) Setting up of the experiment if any
c) Understanding of the theoretical frame work.
d) Writing of the program for computation if any
e) References

(vi) Group of students working on a particular topic will be required to give a presentation in the beginning of the IV semester i.e. February/ March about the progress made by them during vacations. The presentation should be preferably in the forms of a power point presentation.

(vii) IInd presentation of the progress of the work will be held in April.

(viii) A complete seminar on the project will be held in the month of June before submission of the project report.

(ix) Three copies of the project report will be required to be submitted in the office of the Physics department for final evaluation by the external examiner.

(x) A format of the project report as per the details given in below:

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

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. in Physics)
Session
Month Year

Page 2

(Preferably on (Guide's) letter head)

Certificate

This is to certify that the project entitled "**Title of Project**" aimed at " Project purpose" was worked upon by the following students under my supervision at Physics Laboratory 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 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 Report

The following instructions be strictly adhered to while formatting the Project 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 Report
Last date for submission of project report shall be one month after the last theory paper examination of IV Semester for regular students.
